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RISK ASSESSMENT
PROPOSED HOUSING AREAS 1 AND 2
NAVAL STATION TREASURE ISLAND
HUNTERS POINT ANNEX

Volume 1

DEPARTMENT OF THE NAVY
WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
SAN BRUNO, CALIFORNIA 94066-0727

RISK ASSESSMENT
PROPOSED HOUSING AREAS 1 AND 2
NAVAL STATION, TREASURE ISLAND
HUNTERS POINT ANNEX

VOLUME I

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GLOSSARY OF TERMS

AIC - acceptable intake chronic
AIS - acceptable intake subchronic
calibrate - to standardize
carcinogen - a substance or agent producing or inciting cancer
exposure - a measure of the contact between the chemical and the surfaces of the human body
fetotoxic - toxic to the fetus
fugitive - likely to evaporate, deteriorate, or disappear
indicator chemicals - chemicals which may pose the greatest health risks
inorganic - composed of matter other than plant or animal
LOAEL - lowest observed adverse effect level
MED - minimum effective dose
metamorphosed - to change strikingly the appearance or character of
mutagen - a substance that tends to increase the frequency or extent of mutation
NOAEL - no observed adverse effect level
NOEL - no observed effect level
organic - a compound containing carbon
potable - suitable for drinking
potency - effectiveness of the chemical in producing cancer
q^*_1 - human potency value
risk assessment - the use of the factual base to define the health effects of exposures of individuals or populations to hazardous materials
TLV-STEL - Threshold Limit Value - Short Term Exposure Limit Value
TLV-TWA - Threshold Limit Value - Time-Weight Average
toxicant - a toxic agent
toxicology - a science that deals with poisons, their effect, and the problems involved
unit risk - risk associated with exposure to a chemical at a concentration of 1 ug/m^3 for a lifetime

EXECUTIVE SUMMARY

Five housing areas have been proposed at the Naval Station, Treasure Island, Hunters Point Annex (HPA) by the U.S. Navy. This risk assessment demonstrates that there is negligible human health risk associated with the development and occupation of Proposed Housing Areas 1 and 2. The risk assessments of the other three proposed housing areas will be performed at a later date.

Proposed Housing Areas 1 and 2 are located in the northern portion of HPA. Both proposed housing areas were previously residential areas and there are no indications of industrial use or disposal activities.

To perform this risk assessment, soil and air samples were collected from the proposed housing sites and analyzed for the presence of chemical substances including organics, metals, and asbestos. Soil samples were collected from depths ranging from zero to approximately five feet below the ground surface. Due to the variability expected in air sampling, air samples were collected on at least two separate occasions. Each air sample was collected over a period of eight hours during the normal working day. Air samples were also collected at a location upwind of HPA.

The exposure assessment concentrated on possible exposure pathways to humans. On this basis, three possible exposure pathways were identified: dermal (skin) contact with soils, ingestion of soils, and inhalation of ambient air. Exposure by ingestion of drinking water was not considered because potable water for the proposed housing areas will be supplied by pipeline from the City of San Francisco.

Chemical concentrations were compared to levels expected in similar background soils and levels in upwind air. In soil samples collected from the housing sites, organic chemical contaminants were not detected and metal concentrations and asbestos levels did not exceed background values. Because these concentrations suggest background conditions, the exposure pathways for ingestion and dermal contact were not evaluated further for soils present beneath the proposed housing sites.

Seven volatile and three semivolatile organic compounds were found in air at concentrations either similar to or less than background or upwind concentrations. In general, the chemicals detected in the ambient air are normal for urban areas and do not appear to be associated with potential sources from HPA. Therefore, the risk characterization of selected chemicals detected at the proposed housing sites (as well as in background air samples) indicates the exposure risk is no greater for future occupants of the proposed housing sites than it is for existing residences located upwind of HPA.

1.0 INTRODUCTION

Five housing areas have been proposed on the Naval Station, Treasure Island, Hunters Point Annex (HPA) by the U.S. Navy to meet the projected personnel needs. Three of the proposed housing areas are located within the general vicinity of HPA areas where soil and groundwater contamination have recently been identified in the Confirmation Study Verification Step HPA (EMCON, 1987). The other two areas, Proposed Housing Areas 1 and 2 are former residential areas and there is no evidence of industrial use or disposal activities.

This report contains an assessment of potential human health risks associated with the development and occupation of the Proposed Housing Areas 1 and 2. The risk assessment further evaluates the risks to human health and the environment and is based upon available information from previous studies performed at HPA. A Preliminary Public Health and Environmental Evaluation for HPA contaminant sites is currently underway as part of the Remedial Investigation/Feasibility Study (RI/FS) process (ATT, 1987).

This risk assessment is divided into two volumes: Volume I - Risk Assessment, Proposed Housing Areas 1 and 2, Naval Station, Treasure Island, Hunters Point Annex; and Volume II - Appendices to the Risk Assessment for Proposed Housing Areas 1 and 2, Naval Station, Treasure Island, Hunters Point Annex.

1.1 AUTHORIZATION

This report presents the U.S. Navy's risk assessment for Proposed Housing Areas 1 and 2 located at the HPA in San

Francisco, California. The report was prepared by Aqua Terra Technologies, Inc. (ATT) for the Naval Facilities Engineering Command, Western Division (WESTDIV), under contract number N62474-86-D-0996.

1.2 OBJECTIVES

The objective of this risk assessment is to evaluate risks to human health from potential toxic chemical exposures associated with developing and using residential facilities at proposed HPA Housing Areas 1 and 2.

The risk assessment is intended to provide qualitative and quantitative estimates of potential human exposures and health risks associated with both the construction and occupation of housing facilities at these sites.

1.3 ORGANIZATION

The scope of work for the Risk Assessment for the HPA Proposed Housing Areas 1 and 2 included the following tasks:

- o Development of a risk assessment plan;
- o Evaluation of available data on chemical substances identified at HPA locations in proximity to the proposed housing areas to evaluate migration pathways and the potential for chemical exposures to future residents from these potential sources;
- o Sampling of the air at the proposed housing areas and reference areas to identify and quantify

concentrations of airborne chemicals at potentially critical exposure points;

- Evaluation of local wind data in order to define prevailing wind conditions and to evaluate the representativeness of air sampling conditions;

- Evaluation of soil sample data from the proposed housing areas to determine if sources of on-site contamination exist and to identify and quantify chemical substances found;

- Estimation of potential exposures to chemicals identified in samples collected at the proposed housing areas;

- Characterization of health risks to receptor populations at Proposed Housing Areas 1 and 2 associated with estimated potential exposures

This risk assessment report was prepared according to the Environmental Protection Agency (EPA) guidelines for estimating exposures (Federal Register, 1986a) and health risks from suspected developmental toxicants (Federal Register, 1986b), mutagens (Federal Register, 1986c), and carcinogens (Federal Register, 1986d). The report follows the general guidelines for risk assessment provided by the National Research Council (NRC, 1983) and the specific guidelines for air toxic source assessment provided by the California Air Resources Board (CARB) and EPA Region IX (Engineering Science, 1986). The Superfund Public Health Evaluation Manual (EPA, 1986) was referred to for guidance on EPA procedures for hazardous waste site evaluations.

The report is organized into 11 sections beginning with an Introduction in Section 1. A description of the HPA proposed housing areas is provided in Section 2. Background information on the risk assessment exposure routes and specific contaminant problems at the HPA near the proposed housing areas is presented in Section 3. A description of air sampling and soil sampling methods is presented in Section 4. Chemical concentrations identified in air and soil samples are discussed in Section 5. The toxicology and health effects information for identified chemicals is summarized in Section 6. The potential receptor populations are described in Section 7. The exposure routes are identified and described in Section 8. Point exposure concentrations are estimated in Section 9 and potential health risks are characterized in Section 10. The human health risk assessment is summarized in Section 11.

1.4 DATA LIMITATIONS

The data collected at the proposed housing sites and other areas within HPA are a part of the integrated studies which have been conducted by the U.S. Navy to identify, characterize, and remediate areas of chemical contamination. Data generated as part of this risk assessment and existing data collected at earlier dates were considered in preparing the risk assessment for Proposed Housing Areas 1 and 2. This risk assessment is not a component of the Public Health and Environmental Evaluation that will be performed during the remedial investigation feasibility study (RI/FS) being conducted at HPA.

2.0 DESCRIPTIONS OF HPA HOUSING AREAS 1 AND 2

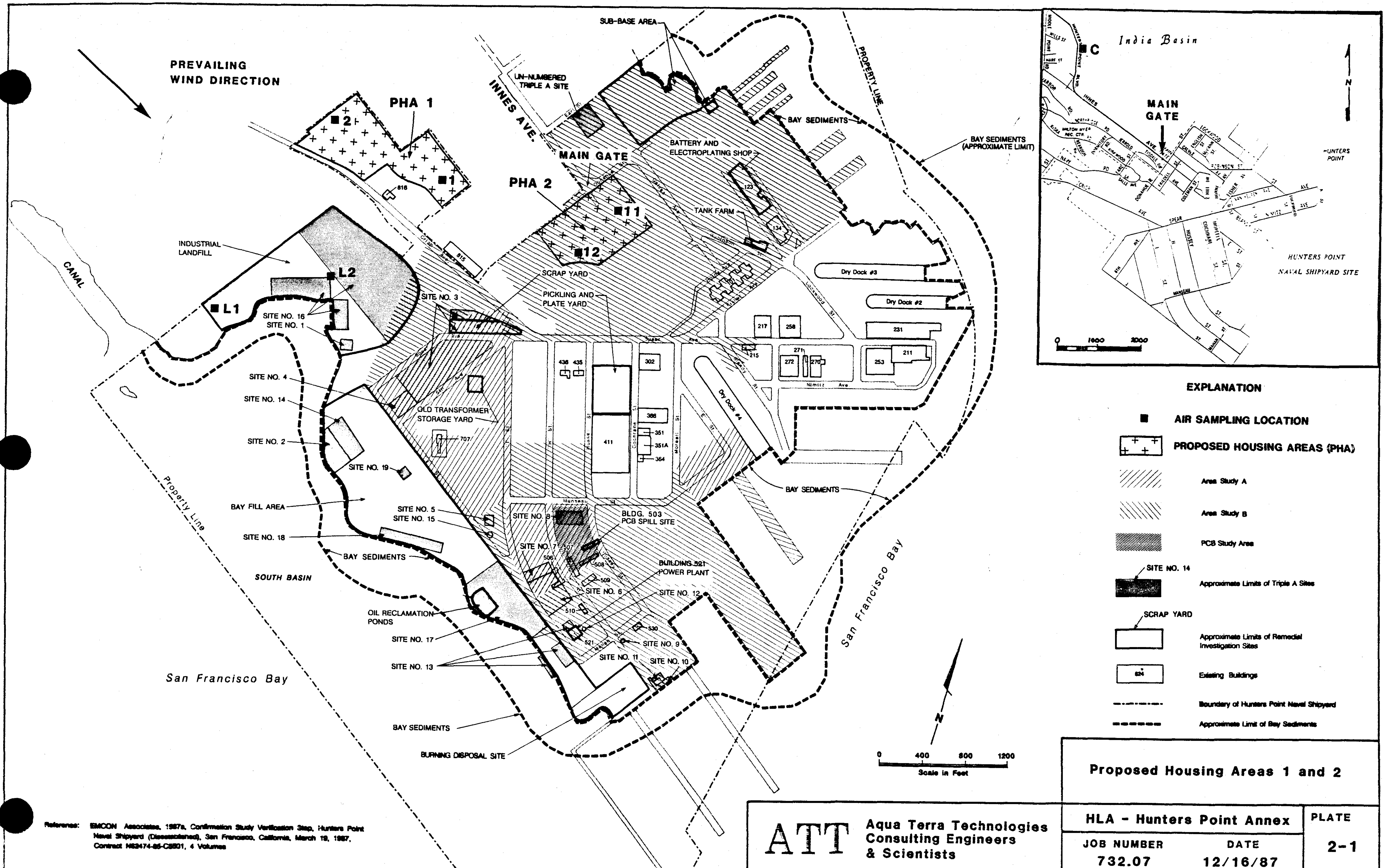
The following descriptions of HPA Proposed Housing Areas 1 and 2 include the location, history, and geology of these sites.

2.1 LOCATION

The HPA occupies nearly 522 acres of land bordering the San Francisco Bay in the Hunters Point area of San Francisco, California. The HPA location is shown on a site map presented on Plate 2-1. This map identifies the locations of the two proposed housing areas and shows their proximity to the 11 sites currently included in the Remedial Investigation.

Proposed Housing Area 1 is approximately 14.8 acres in size and is located on the hillside above Crisp Avenue and bisected by Navy Road (see shaded area marked PHA1 on Plate 2-1). Proposed Housing Area 1 is located in relatively close proximity (400 feet) to the Industrial Landfill, however, elevations range from about 30 to 150 feet above the landfill.

Proposed Housing Area 2 is approximately 11 acres in size and is located on a hill east of the Main Gate to the HPA. Proposed Housing Area 2 is bounded by Jerrold Avenue, Coleman Street, and Galvez Avenue (see area marked PHA2 on Plate 2-1). Proposed Housing Area 2, located on a small hill, is within 1,000 feet of the Scrap Yard, Pickling and Plating Yard, Tank Farm, and Battery and Electroplating Shop.



Reference: EMCON Associates, 1987a, Confirmation Study Verification Step, Hunters Point Naval Shipyard (Disestablished), San Francisco, California, March 19, 1987, Contract N62474-86-C8601, 4 Volumes

Proposed Housing Areas 1 and 2

ATT Aqua Terra Technologies Consulting Engineers & Scientists

HLA - Hunters Point Annex		PLATE
JOB NUMBER 732.07	DATE 12/16/87	2-1

2.2 HISTORY OF PROPOSED HOUSING AREAS 1 AND 2

2.2.1 Proposed Housing Area 1

Proposed Housing Area 1 was previously a residential area. The houses were demolished in the early 1960s and the site presently consists of a series of foundations over-grown with grasses and shrubs. No structures remain in place and there are no maintained roads, sewers, or water hookups. Proposed Housing Area 1 is presently fenced to restrict access. There are no visible indications that Proposed Housing Area 1 has hosted any industrial or other disposal activities which may have had an impact on soil or air quality.

2.2.2 Proposed Housing Area 2

Proposed Housing Area 2 is a residential area formerly occupied by Navy personnel and employees of Triple A Machine Shop (the former leasee). Three houses in Proposed Housing Area 2 are presently occupied by civilian tenants. Most of the unoccupied houses in Proposed Housing Area 2 are standing structures although many are in a neglected condition. This area has paved streets and the water and sewer systems are reportedly intact. There are no visible indications that Proposed Housing Area 2 has hosted any industrial or other disposal activities which may have contaminated this site.

2.3 Site Geology

Geologic conditions of Proposed Housing Areas 1 and 2 were previously described in "Subsurface Investigation - Proposed Housing Areas 1 and 2, Ex-Hunters Point Naval

Shipyard" (Appendix A, HLA, 1987a). Geologic conditions are summarized below.

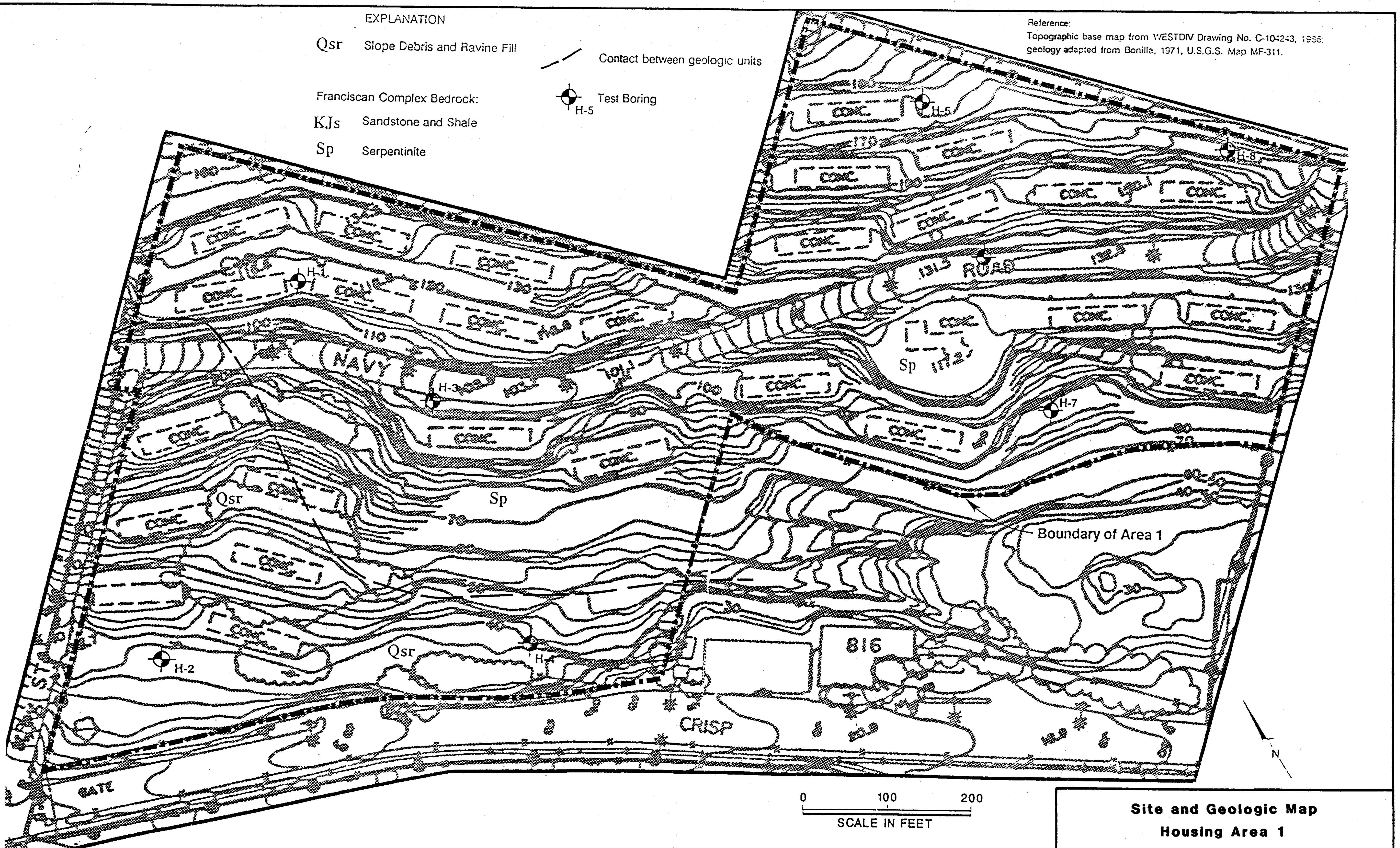
2.3.1 Proposed Housing Area 1

The geologic conditions are shown on the Site and Geologic Map presented on Plate 2-2. Proposed Housing Area 1 is underlain by serpentinite bedrock that is a part of the Franciscan Complex. Serpentinite is extensively exposed in cut faces throughout the area and was generally encountered at shallow depths in the test borings. Borings drilled in the upper northeastern slopes of this area encountered sandy silt surface soils to depths of 1.5 feet which were underlain by serpentinite bedrock. On the lower slopes, soil borings encountered clayey silt and silty sand soils to the depths explored (5.5 to six feet deep). These soils were mapped as slope wash and ravine-fill deposits and were likely derived from erosion and downslope transport of bedrock materials (Bonilla, 1971).

2.3.2 Proposed Housing Area 2

Geologic formations underlying Proposed Housing Area 2 are illustrated on the geologic map presented on Plate 2-3. Surface soil compositions ranged from clayey silt to silty sand. Grading for prior site development has removed soil cover from some areas (Boring H-15) and placed soils as fill in other locations (Boring H-11). Soil depths in the test borings throughout most of this area range from zero to five feet, with the exception of H-14, which was drilled to a depth of 9.5 feet.

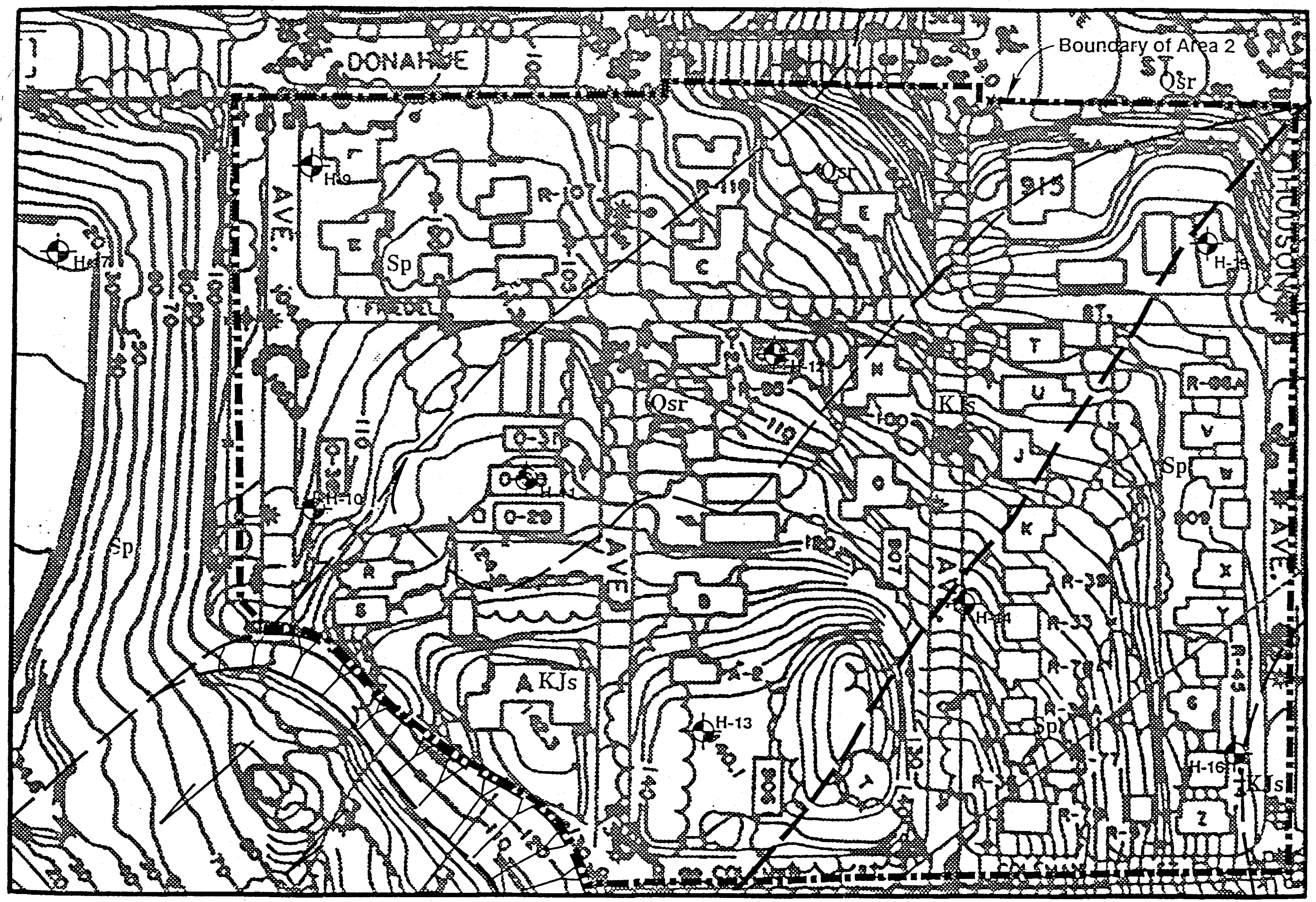
Beneath these surface soils, Proposed Housing Area 2 is underlain by serpentinite and sandstone/shale units of



Site and Geologic Map
Housing Area 1

ATT Aqua Terra Technologies Consulting Engineers & Scientists	HLA - Hunters Point Annex	PLATE 2-2
	JOB NUMBER 732.07	DATE 11/9/87

the Franciscan Complex (Plate 2-3). In addition, Borings H-10 and H-11 encountered greenstone and altered/metamorphosed volcanic rock. A north-trending fault has been mapped between the serpentinite and sandstone/shale units within Proposed Housing Area 2 (Bonilla, 1971). Boring H-14, which was drilled near or within this fault zone, encountered intensively sheared rock that may be fault gouge material. There are no published studies to indicate whether any of the faults at HPA are active. Landslide debris is present in the southern corner of the area, with slope debris and ravine fill deposits mapped at the northwestern and northeastern boundaries (Bonilla, 1971).



EXPLANATION

Qsr	Slope Debris and Ravine Fill

Franciscan Complex Bedrock:

KJs	Sandstone and Shale
Sp	Serpentinite
	Contact between geologic units
	Fault (inactive), approximately located
H-17	Test Boring
	Landslide, showing scarp (teeth) and direction of movement (arrows)

0 100 200
SCALE IN FEET

N

Reference:
Topographic base map from WESTDIV Drawing No. C-104243, 1986; geology adapted from Bonilla, 1971, U.S.G.S. Survey Map MF-311.

Site and Geologic Map
Housing Area 2

ATT Aqua Terra Technologies Consulting Engineers & Scientists	HLA - Hunters Point Annex		PLATE
	JOB NUMBER 732.07	DATE 11/9/87	2-3

3.0 BACKGROUND

An Initial Assessment Study (IAS) (WESTEC, 1984) and a Confirmation Study Verification Step (CSVS) (EMCON, 1987a) were conducted to identify chemical contaminants at the HPA. In addition, EMCON conducted studies for WESTDIV in two areas at HPA where shallow borings were drilled on a 200-foot and 400-foot grid (EMCON 1987b). These studies provide the preliminary data base for the HPA RI/FS Scoping Document (HLA, 1987b). Eleven Installation Restoration (IR) sites are identified in the Scoping Document. Human health and environmental risks associated with exposures to chemicals released from these 11 IR sites are being assessed in the Preliminary Public Health and Environmental Evaluation (PPHEE) (ATT, 1987).

Conclusions from current field investigations at the HPA are summarized in this section in order to identify the potential sources of chemical releases in the vicinity of the proposed housing areas. This information provides a basis for assessing potential exposures to humans at Proposed Housing Areas 1 and 2 associated with potential chemical releases from the 11 identified IR sites.

3.1 PRELIMINARY PUBLIC HEALTH AND ENVIRONMENTAL EVALUATION

The PPHEE presented the following conclusions:

- Metals at concentrations above expected background levels and organic chemical contaminants were found in soils at several source areas including the Oil

Reclamation Ponds, Industrial Landfill, Bayfill Area, Sub-base Area, Scrap Yard, and the Old Transformer Storage Yard.

- Metal and organic chemicals were found in ground water at the Oil Reclamation Ponds, Industrial Landfill, Bayfill Area, and Sub-base Area.

- Human exposures through ingestion of drinking water degraded by HPA sources would be virtually impossible in that potable water is supplied to HPA residents by pipeline from the City of San Francisco supply sources.

- The most likely routes of human exposure are through dermal contact with contaminated surface soils, ingestion of contaminated soils, or through inhalation of chemicals from volatile compounds or fugitive dust emissions. The PPHEE suggests that the probability of exposures to chemical substances from one of these exposure routes is unlikely.

The transport of airborne chemicals from HPA sources to Proposed Housing Areas 1 or 2 constitutes the only likely exposure scenario associated with known chemical sources in the HPA area. The PPHEE identified the following indicator chemicals in near surface materials (at approximately one foot depth) as presenting a possible health risk if exposures are shown to occur.

Inorganic Compounds

- arsenic
- asbestos
- chromium
- copper
- lead
- nickel
- zinc

Organic Compounds

- benzo(a)pyrene
- polychlorinated biphenyls (PCBs)

The above list suggests that airborne releases may contain asbestos fibers, certain metals associated with dust, and aerosol and particulate-associated organic compounds.

The prevailing wind direction at the HPA is from the west-northwest (CARB, 1984). Proposed Housing Areas 1 and 2 are located generally north and east of known chemical sources. Thus, prevailing winds would likely carry released airborne chemicals from the potential sources toward the southeast in a direction away from Proposed Housing Areas 1 and 2.

3.2 RISK ASSESSMENT DESCRIPTION

3.2.1 The Risk Assessment Process

Some judgement of the magnitude of risk from toxic chemical and hazardous material exposures enters explicitly or implicitly into all control decisions whether they involve regulatory or other protection measures. Risk assessment is the characterization of potential adverse human health effects due to exposures to identified environmental hazards. Risk assessment, therefore, involves a characterization of exposure, effect of the exposure, and the relationship between exposure and effect. No health risk exists unless an exposure to a hazardous substance has taken place or is possible. The expression of risk may be quantitative (a numerical probability of an adverse effect), or it may be qualitative and presented as a ranking of relative risk.

The risk assessment process includes several elements:

- Identification of toxic substances or hazardous materials;

- Description of the potential adverse human health impacts based on evaluations of results of chemical, epidemiological, toxicological, and environmental studies;

- Extrapolations from known information to predict the type and extent of impact under given conditions of exposure;

- Judgment as to the number and characteristics of persons or wildlife populations exposed at various intensities and concentrations;

- Estimates of the overall public health or environmental problem;

- Characterization of the uncertainties inherent in the process of inferring risk.

3.2.2. Risk Assessment Strategy

This risk assessment is based on consideration of three possible exposure pathways:

- Inhalation of airborne chemicals from volatile chemical releases or fugitive dust emissions from sources located either on or adjacent to the Proposed Housing Areas 1 and 2;

- Dermal contact with chemicals that might be present in surface soils at Proposed Housing Areas 1 and 2 during construction or excavation activities, normal outdoor work, and play activities;

- Ingestion associated with children eating surface soil that might contain chemicals at Proposed Housing Areas 1 and 2.

Drinking water ingestion was not considered as a possible exposure pathway because potable water for HPA is supplied by the City of San Francisco Municipal water system.

The viability of the three possible exposure pathways was assessed by determining if substances exist in air or soil at Proposed Housing Areas 1 and 2. Site investigations and sampling strategies are described in Section 4 and sampling results are reported in Section 5.

The receptors of concern for this risk assessment are the persons, both adult and children, who would occupy the housing units after construction. Also of concern are the workers who might be subjected to short-term exposure during construction of the housing units.

Exposure concentration estimates used in the risk assessment were based on measured levels of identified chemicals in soil or air. The toxicity of identified chemicals was summarized to identify toxic effects, potential carcinogens, and regulatory safe levels. Risk for exposures to non-carcinogens was estimated by comparing maximum measured concentrations with regulatory criteria. Risk for exposures to potential carcinogens was estimated by multiplying lifetime exposure levels by the potency value of the carcinogen.

4.0 SUPPORTING INVESTIGATIONS

Field investigations were conducted to ascertain if sources of chemicals exist in the air or the soil at Proposed Housing Areas 1 and 2.

4.1 AIR SAMPLING INVESTIGATION

The meteorology of HPA, air sampling locations, and air sampling methodologies used during air sampling are discussed in the following sections.

4.1.1 Meteorology of Hunters Point

Hunters Point shares the generally moderate climatic conditions of the San Francisco Bay Area, with a mean annual temperature of 56.6 ^{o}F, 10.7 inches mean annual rainfall generally occurring between September and May, and winds predominating out of the west-northwest at a mean speed of 11 miles per hour (NOAA, 1982; CARB, 1984).

Weather patterns during September, the month in which air samples were collected, are characterized by a mean temperature of 63.9^{o}F, 0.2 inches of rainfall, and winds out of the west-northwest at 12 miles per hour. Actual meteorological parameters observed during the five days of sampling are consistent with these averages. The mean temperature for the five days sampled was 63.3^{o}F, there was no precipitation, and the winds were predominantly from the west-northwest.

Meteorological data used in these comparisons was generated at San Francisco International Airport (SFO), where wind speed, wind direction, temperature, and barometric pressure are recorded hourly by the Federal Aviation Administration. Because HPA is located adjacent to hills, eight miles due north of SFO, wind patterns are likely to be slightly different. However, no wind records have been maintained at the HPA, therefore, the SFO data was used for comparison. Surface wind characteristics at SFO on the five sampling dates, are summarized in Table 4-1. The table represents average direction and speed derived from hourly observations for the ten hour period beginning at six in the morning and ending at eight in the evening on each of the days sampled. Wind speeds ranged from four to 19 miles per hour and north-westerly winds dominated during the sampling period.

Winds during the five day sampling period compared well to average conditions for summer and fall. Northwest was the prevailing direction during the five day sampling period. Wind roses were not plotted because the 50 hourly observations do not provide a sufficient data base. Fourteen of 16 compass points were represented during the sampling period and calm conditions were present for parts of two days of sampling. Thus, it appears that wind characteristics during the five day sampling period are representative of the long-term average wind characteristics recorded at San Francisco International Airport (SFO). A more detailed description of surface wind characteristics identified at HPA is presented in Appendix B.

4.1.2 Air Sampling Location

Air sampling for potential air contaminants was conducted on September 2, 4, 8, 10, and 18, 1987 at Proposed Housing Areas 1 and 2, the Industrial Landfill,

Table 4-1. Wind Directions, Wind Speed, and Frequency of Occurrence at the San Francisco International Airport on Dates of Air Sampling at HPA Locations

Direction	9/02/87		9/04/87		9/08/87		9/10/87		9/18/87	
	%	MS[a]	%	MS[a]	%	MS[a]	%	MS[a]	%	MS[a]
N	-	-	-	-	-	-	-	-	-	-
NNE	-	-	-	-	8%	7	-	-	7%	7
NE	-	-	-	-	8%	7	-	-	-	-
ENE	-	-	-	-	15%	6	-	-	7%	7
E	-	-	-	-	-	-	-	-	7%	6
ESE	-	-	-	-	8%	5	-	-	-	-
SE	-	-	8%	4	-	-	-	-	-	-
SSE	-	-	-	-	-	-	-	-	-	-
S	-	-	-	-	8%	5	-	-	-	-
SSW	-	-	8%	8	8%	7	-	-	-	-
SW	-	-	17%	14	-	-	-	-	-	-
WSW	-	-	33%	14	7%	4	-	-	-	-
W	-	-	25%	12	-	-	21%	19	13%	5
WNW	27%	8	-	-	8%	19	50%	18	-	-
NW	73%	14	-	-	23%	17	21%	16	53%	16
NNW	-	-	-	-	-	-	8%	12	13%	9
CALM	-	-	17%	-	7%	-	-	-	-	-

MS[a] = Mean Speed (miles per hour)
\- No Wind detected from the described direction
Source: Federal Aviation Administration Control Tower, San Francisco International Airport

and a Control Station. The Control Station was located at an upwind or background location selected on the specified sampling date. Locations within the Proposed Housing Areas 1 and 2 were selected following examination of wind patterns and locations of suspected sources of potential air contaminants to allow for the collection of samples which represented worst-case conditions at each site. Air samples were collected continuously over an eight-hour period at the selected stations. The number of eight-hour air samples collected is presented in Table 4-2.

4.1.2.1 Proposed Housing Area 1

Two air sampling stations were located in Proposed Housing Area 1. Sampling Station 1 was located on the downhill eastern edge of the first concrete foundation encountered at this area when proceeding west on Navy Road from Earl Street (see Plate 2-1). Sampling Station 2 was located on the downhill eastern edge of the second concrete foundation encountered at Proposed Housing Area 1 when proceeding west (downhill) on Navy Road from Earl Street. Sampling Station 2 was located approximately 300 feet west of Sampling Station 1 and approximately 60 feet lower on the hillside. Air sampling pumps at both stations were fixed to wooden posts in order to elevate them to the approximate breathing level of an adult (approximately five feet above ground level).

Wind direction during sampling was determined at two hour intervals using a compass and wind sock. Winds at the two stations blew predominantly out of the west (see Table 4-3). Although the two stations are in close proximity to each other, winds at Station 1 were primarily out of the south-southwest whereas winds at

Table 4-2. Number of Eight-hour Air Samples Collected at the Control Station, Proposed Housing Areas 1, 2, and the Industrial Landfill, During the September, 1987 Sampling Period

Substance	Number of Samples			
	Control	**Proposed Housing (Area 1)**	**Proposed Housing (Area 2)**	**Industrial Landfill**
Volatile Organic Chemical	2	3	4	4
Semivolatile Organic chemical	2	4	4	4
Metals	2	4	4	4
Asbestos	1	4	4	4

Table 4-3. Field Wind Directions and Potential Upwind Sources During Sampling Periods at Sample Stations Within Proposed Housing Areas 1 and 2

Date	Sample[a] Station	Wind[b] Direction	Upwind[c] Source
9/2/87	1d	SSW	Landfill
		SSW	Landfill
		W	(Off-Base)
		W	(Off-Base)
9/8/87	1	NE	(Off-Base)
		SSW	Landfill
		NW	(Off-Base)
		NW	(Off-Base)
9/18/87	1	SW	Landfill
		SW	Landfill
		WSW	(Off-base)
		WSW	(Off-base)
9/2/87	2	WNW	(Off-Base)
		WNW	(Off-Base)
		WNW	(Off-Base)
		WNW	(Off-Base)
9/8/87	2	NE	(Off-Base)
		S	Landfill
		WNW	(Off-Base)
		NW	(Off-Base)
9/18/87	2e	SW	(Off-base)
		SW	(Off-base)
		SW	(Off-base)
		SW	(Off-base)

a Sample station locations are presented on Plate 2-1.
b Wind directions are two hour averages for the eight hour sampling period at each station.
c Sources are as described in Section 3.1.
d No air samples were collected on this date because of pump failure; Station 2 was resampled on 9/18/87.
e No air samples were collected on this date because of two prevsious successful collections.

Station 2 were primarily out of the west-northwest. The difference observed is likely due to the influence of local topography.

A potential HPA source for the release of air contaminants that could be transported to Proposed Housing Area 1 is the Industrial Landfill (see Table 4-2). Other potential sources located off-base may also play a role in the air quality at Proposed Housing Area 1. Characterization of these sources is beyond the present scope of work, however, the Industrial Landfill is thought to present the greatest potential source of chemicals adjacent to Housing Area 1.

Sampling Station 1 was exposed to winds emanating from the direction of the Industrial Landfill approximately 40 percent of the total 24-hour sampling period. Sampling Station 2 was located downwind from the Industrial Landfill approximately 10 percent of the total sampling period. Both sampling stations were downwind from the southeastern residential area of the Bay View Hunters Point Community and potential off-base sources for the balance of the sampling periods.

4.1.2.2 Proposed Housing Area 2

The location of Sampling Stations 3 through 10, respective sampling methodology, and wind conditions are not described in this report because this information does not pertain to Proposed Housing Areas 1 and 2. Sampling Stations 11 and 12 were located within Proposed Housing Area 2 (see Plate 2-1). Sampling Station 11 was located at the stop sign at the corner of Innes Avenue and Coleman Street. Air sampling pumps were affixed to the stop sign at an adult breathing zone approximately five feet above ground level using metallic wire. Sampling Station 12 was located at the corner of Jerrold Avenue and Coleman Street. Air sampling pumps at Station 12 were affixed to wooden poles at approximately five feet above ground level.

Winds at both stations blew out of the northwest more than 50 percent of the time during the total 24-hour sampling period (see Table 4-4). Sampling Station 11 was subjected to winds blowing from the direction of the unnumbered Triple A site located adjacent to the Main Gate for half of one sampling period, and to winds from the direction of the off-base residential community during the balance of the total sampling period. Sampling Station 12 was downwind from the off-base residential community for two full sampling periods and subjected to winds from the direction of the Tank Farm and the Pickling and Plating Yard for approximately four hours of sampling on September 18, 1987.

4.1.2.3 Industrial Landfill

Two sampling stations were positioned on the Industrial Landfill in order to provide some quantification of any toxic air emissions being generated from the landfill (see Plate 2-1 for locations). The first of these stations, L1, was located on a raised fill area approximately 630 feet from the east gate along the access road to the landfill. The second station, L2, was located approximately 720 feet west-southwest of L1. Sampling Station L2 was located on the lower original level of the Industrial Landfill, whereas L1 was located approximately 15 feet higher on a raised cover of earthen fill. Air sampling pumps at both stations were fixed to wooden poles in order to elevate them to

Table 4-4. Field Wind Directions and Potential Upwind Sources During Sampling Periods at Sample Stations Within Proposed Housing Area 2

Date	Sample[a] Station	Wind[b] Direction	Upwind[c] Source
9/4/87	11	NW	(Off-base)
		NW	(Off-base)
		WNW	Triple A site
		WNW	Triple A site
9/10/87	11	NW	(Off-base)
		NW	(Off-base)
		NW	(Off-base)
		NW	(Off-base)
9/4/87	12	W	(Off-Base)
		NW	(Off-Base)
		WNW	(Off-Base)
		W	(Off-Base)
9/10/87	12[d]	WNW	(Off-Base)
		WNW	(Off-Base)
		WNW	(Off-Base)
		WNW	(Off-Base)
9/18/87	12	calm	-
		ENE	Tank Farm
		ESE	Pickling & Plate Yard
		WNW	Off-Base

a Sample station locations are presented on Plate 2-1.
b Wind directions are two hour averages for the eight hour sampling period at each station.
c Sources are as described in Section 3-1.
d No air sample was collected on this date due to pump failure; Station 12 was resampled on 9/18/87.

approximately adult breathing levels (approximately five feet above ground level).

Winds at the two sampling stations on the Industrial Landfill were predominately out of the west on both days sampled (See Table 4-5). At Sampling Station L1, winds blew in the same direction for the duration of each sampling period, whereas, wind direction at Sampling Station L2 showed some variation within the western half of the compass.

4.1.2.4 Control Station

A Control Station was established off-base for the collection of a background, off-site, ambient air sample. A number of industrial sources as well as two freeways which carry a heavy volume of vehicular traffic, and an oil-fired power plant exist upwind from the HPA.

The Control Station was located on Hunters Point Boulevard at the guardrail adjacent to a billboard owned by Patrick Billboard Company (see Plate 2-1). This location is on the bend in the road south of the power plant. The Control Station is located northwest of Proposed Housing Areas 1 and 2 and therefore was generally upwind from the proposed housing areas.

Winds at the Control Station blew consistently out of the northwest for each of the three sampling periods (see Table 4-6). Emission characteristics of individual industries in the India Basin Industrial Park were not examined. The primary potential sources upwind of the Control Station were the India Basin Industrial Park and automobile exhaust from traffic to and from the HPA.

Table 4-5. Field Wind Directions and Potential Upwind Sources During Sampling Periods at Sample Stations Within Industrial Landfill

Date	Sample[a] Station	Wind[b] Direction	Upwind[c] Source
9/2/87	L1	WNW	Landfill
		WNW	Landfill
		WNW	Landfill
		WNW	Landfill
9/8/87	L1	W	Landfill
		W	Landfill
		W	Landfill
		W	Landfill
9/2/87	L2	WNW	(Off-base)
		WNW	(Off-base)
		W	(Off-base)
		W	(Off-base)
9/8/87	L2	S	Landfill (bay)
		SSW	Landfill (bay)
		WNW	(Off-base)
		NW	(Off-base)

a Sample station locations are presented on Plate 2-1.
b Wind directions are two hour averages for the eight hour sampling period at each station.
c Sources are as described in Section 3.1.

Table 4-6. Field Wind Directions and Potential Upwind Sources During Sampling Periods at Sample Stations Within the Proposed Housing Areas 1 and 2

Date	Sample[a] Station	Wind[b] Direction	Upwind[c] Source
9/4/87	C	NW	India Basin, Industrial Sites
		NW	India Basin, Industrial Sites
		WNW	India Basin, Off-base Residences
		WNW	India Basin, Off-base Residences
9/10/87	C	WNW	India Basin, Off-base Residences
		W	India Basin, Off-base Residences
		WNW	India Basin, Off-base Residences
		WNW	India Basin, Off-Base Residences
9/18/87	C	WNW	India Basin, Off-Base Residences
		WSW	India Basin, Off-base Residences
		WNW	India Basin, Off-Base Residences
		NW	India Basin, Industrial Sites

a Sample station locations are presented on Plate 2-1.
b Wind directions are two hour averages for the eight hour sampling period at each station.
c Sources are as described in Section 3-1.

Winds did not blow power plant emissions towards the Control Station during the sampling period.

4.1.3 Air Sampling Methodology

The ambient air was sampled for chemicals at the five locations described in Section 4.1.1 on two separate occasions during the weeks of September 2 to September 18, 1987. Air samples at the Control Station were collected on three separate occasions. The sampling period was eight hours per day.

The analysis of the ambient air samples collected included volatile organic compounds (VOCs), extractable semivolatile acid and base/neutral organic compounds (SOCs), particulate metals, and asbestos. The sampling media and procedures used for the air sample collection are described below.

4.1.3.1 <u>Volatile Organic Compounds</u>

The sampling of volatile organic compounds (VOCs) was accomplished using low-flow air sampling pumps. The pumps were manufactured by Mine Safety Appliances, Gillian, SKC, and DuPont and were calibrated at 500 milliliters per minute using an SKC rotameter calibrator, as prescribed by the National Institute of Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NIOSH, 1984). Pumps were initially calibrated on the premises of ATT, and again at each of the sampling locations. Flow rates were measured every two hours using the rotameter during the prescribed eight-hour sampling period to verify a constant flow rate. A final measurement was taken just prior to disconnecting the sampling apparatus at the end of the sampling period. Flow rates found to vary more than 10 percent from the prescribed flow rate were adjusted to the proper flow rate. In some cases, pumps were found to deliver insufficient flow rates or stopped functioning altogether. Samples collected from pumps which malfunctioned at some point during the sample collection period were discarded and the sampling was repeated.

SKC Tenax sorbent tubes were used for the selective sampling of VOCs in the ambient air. Tenax sorbent air sample tubes are a NIOSH and Occupational Safety and Health Association (OSHA) approved method for sampling VOCs. Tenax is a specialized sorbent media sealed in a glass tube. Two layers of the sorbent, separated by foam partitions, are packed in the glass tube to ensure uniform pressure drop through the tube.

Sampling was accomplished by breaking the glass tips of the tubes and attaching them to Tygon tubing secured to the air sampling pumps. The sample flow rate was approximately 500 milliliters per minute for the prescribed period of eight hours. At the end of the eight hour period, the tubes were capped with plastic caps which were sealed with Teflon tape. Each tube was labeled appropriately, sealed in a Zip-loc bag and placed on ice before being dispatched for analysis to Data Chem Laboratories located in Salt Lake City, Utah. Data Chem Laboratories is NIOSH certified for the analysis of air samples for occupational exposure. The samples were accompanied by proper chain of custody documentation.

Contaminants in air samples were identified and quantified using gas chromatography/mass spectrometry

(GC/MS) instrumentation. The sorbent tube extraction process used by Data Chem Laboratories is described in Appendix C.

Actual air chemical concentrations were calculated by dividing the mass of each individual chemical by the adjusted volume of air sampled. Volumes of air sampled were determined as a product of the flow rate and the sample period, and were adjusted for temperature and pressure using the NIOSH formula:

$$V \text{ (Corrected volume, L)} = Q(t)(P_c\ T_s/P_s\ T_c)^{0.5}$$

where:
- Q = indicated flow rate (L/min)
- t = sampling time (min)
- P_c = pressure during calibration of sampling pump (kPa or other pressure units)
- P_s = pressure of air sampled (same units as P_c)
- T_c = temperature during calibration of sampling pump (degrees Kelvin)
- T_s = temperature of the air sampled (degrees Kelvin)

Laboratory reports including a description of analytical methods and a list of chemicals with detection limits and measured concentrations are presented in Appendix C.

4.1.3.2 Semivolatile Organic Compounds

The sampling of semivolatile organic compounds (SOCs) was accomplished using the same array of sampling pumps described for the VOCs. The media for the selective collection of SOCs was SKC XAD-2 sorbent tubes. XAD-2 tubes are used in the same manner that Tenax tubes are used. XAD-2 is the SKC trade name for a porous aromatic polymer which is optimal for adsorption of SOCs.

The sampling pumps were calibrated on the premises of ATT and again at each sampling location. The sampling flow rate using XAD-2 sorbent tubes was 500 milliliters per minute for an eight-hour sampling period. The sample flow rates were checked every two hours using a rotameter calibrator. The same criteria for adjusting pumps and abandoning sample runs used for the Tenax tubes were applied again with the XAD-2 tubes. At the end of the eight-hour sampling period, the XAD-2 tubes were capped and sealed with Teflon tape, labeled appropriately, sealed in Zip-loc bags, and packed in ice for dispatch to Data Chem Laboratories for analysis. The samples were accompanied by proper chain of custody documentation.

Chemicals in air samples were identified and quantified using GC/MS. Air chemical concentrations were calculated using the same methods described in the previous section. Laboratory reports including laboratory methodology, chemical quantities detected, and the detection limits are presented in Appendix C.

4.1.3.3 <u>Heavy Metals</u>

The ambient air was sampled for the 17 heavy metals listed in California Administrative Code (CAC), Title 22, Section 66699, using high-flow air sampling pumps and 37 millimeter mixed cellulose ester filters (MCEF). The MCEFs were coupled with pure cellulose support pads and housed in clear polystyrene filter cassette blanks, attached to Tygon tubing with nylon adapters. Cassettes were loaded with MCEFs and support pads using stainless steel forceps to avoid inadvertent contamination of the sampling media. Cassette sealing bands were used to secure the cassettes during handling and sampling. The pumps were operated at a sampling rate of two liters per minute for the prescribed eight-hour sampling period.

At the end of the eight-hour sampling period, the cassette port openings were closed using the plastic caps provided by the manufacturer, appropriately labeled, sealed in Zip-loc bags, and placed on ice for shipment to Data Chem Laboratories for analysis. The samples were accompanied by proper chain of custody documentation.

Heavy metals were analyzed using Inductively-Coupled Argon Plasma Emission (ICAP) instrumentation.

Laboratory procedures, detection limits, and chemical quantities detected are presented in Appendix C.

4.1.3.4 Asbestos

The collection of airborne asbestos fibers was accomplished using high flow air pumps and MCEFs. The NIOSH protocol for the collection of asbestos fibers was followed which included a sampling flow rate of two liters per minute for a sampling period of eight hours. Filter cassettes were loaded with 37 millimeter MCEFs and pure cellulose support pads using stainless steel forceps. The cassettes were then sealed with cassette sealing bands. Tygon tubing was used to attach the loaded cassette to the sampling pump.

Upon completion of the eight-hour sampling period and the determination of final flow measurements, the filter cassettes were removed from the pumps and closed with plastic caps. The filter cassettes were labeled appropriately and sealed in plastic bags. Samples were not placed on ice, but rather kept in a cool dry environment to avoid contamination from bacteria present in moist environments.

Samples accompanied by proper chain of custody documentation, were dispatched to TMA/Norcal Laboratories located in Richmond, California, for analysis using Transmission Electron Microscopy (TEM). TEM was chosen over polarized light microscopy analysis because of its superior ability to quantify and classify individual asbestos fibers present on the filters. Laboratory reports including laboratory procedures, detection limits, and analytical results are presented in Appendix C.

4.1.3.5 Blanks

Field Blanks were prepared with each sampling media used for the collection of air samples. The sorbent tube field blanks were prepared for analysis by breaking off the glass tips of a sorbent tube, immediately capping the ends of the tube and sealing the caps with Teflon tape. The MCEF blanks were prepared for analysis by placing a MCEF into a cassette which was then capped and sealed. No field blanks were ever attached to sampling pumps. The field blanks were transported together with the actual collected samples to the analytical laboratory for analysis, accompanied by proper chain of custody documentation.

4.1.4 Verification of Collection of Representative Samples

Air sampling stations were strategically located with the objective of best representing average conditions affecting airborne contaminant emission and transport. Necessarily, the question of whether representation of average meteorological conditions was adequate can only be examined after samples have been collected. As discussed above, it is believed that the days on which samples were obtained are indeed representative of average meteorological conditions.

Other factors contributing to the emission of airborne contaminants from sources of contamination include dry particle size distribution of exposed soil, soil moisture levels, surface vegetation, and ambient temperatures. HPA sites, such as the Industrial Landfill, are expected to have a substantial fraction of surface particles of a size that can be easily wind eroded. Due to the lack of rain from April to September, 1987, the surface soil moisture content was low. In addition sparse vegetation cover over a majority of the landfill would increase the potential transport of airborne contaminants. Consequently, the set of meterological and soil conditions encountered at HPA Proposed Housing Areas 1 and 2 were reasonably representative of approximate worst-case emission conditions.

4.2 SOIL SAMPLING INVESTIGATIONS

Soil sampling and analysis was performed under the direction of Harding Lawson Associates (HLA). The results of the investigation were provided to ATT. Soil sampling investigations are described below.

4.2.1 Field Sampling

Subsurface conditions were explored by drilling 17 soil borings (Borings H-1 through H-17) using a truck-mounted eight inch diameter hollow-stem auger drill rig, with the exception of soil Boring H-7 which was drilled using hand auguring methods. The boring locations shown on Plates 2-2 and Plate 2-3 were selected to provide, within the limits of equipment access, a general screening of near-surface chemical conditions in Proposed Housing Areas 1 and 2. The total depth of the hollow-stem auger borings ranged from 4.5 to 35.0 feet below ground surface. Boring H-7 was hand-sampled because the site was inaccessible to a drill rig. Borings H-3, H-6, H-11, and H-14 were drilled to depths of approximately 20 feet in an attempt to sample groundwater as well as soil. Because no groundwater was encountered in these four borings, Boring H-17 was drilled to a depth of 35 feet at a lower elevation west of Proposed Housing Area 2. Groundwater was not encountered at the lower elevation, consequently no groundwater sample was collected.

The borings were logged by an HLA field geologist according to the Unified Soil Classification System. Soil and rock samples were collected using a split-barrel sampler driven into undisturbed soil ahead of an auger with a 140-pound hammer. Samples to be submitted for chemical analysis were collected using the split-barrel sampler lined with six inch long stainless steel tubes. Brass tubes were used to collect samples for lithologic logging. In Boring H-7, one soil sample was collected by removing the surface soil to a depth of 0.3 feet and placing it in a stainless steel tube. This sample was submitted for asbestos analysis. A second sample was collected from below the first sample by hammering a stainless steel tube into the ground and removing the tube by excavating the surrounding soil. Foil-lined plastic caps were used to seal the ends of the sample tubes submitted for analysis. Foil was not used when sealing the samples for asbestos analysis. All sampling tubes were labeled and the ends sealed with tape.

Soil samples to be analyzed for metals, VOCs, SOCs, and PCBs were stored on ice for same day delivery to the laboratory. Samples obtained for asbestos analysis were not stored on ice and were submitted to the laboratory at the completion of the field program. Completed chain of custody documentation accompanied all samples. The sample numbering system consisted of the prefix "87" (year) followed by the boring number, and sample depth in feet (for example, 8710-5.0 is Boring H-10 collected at a depth of 5.0 feet).

The augers were steam-cleaned prior to use at the site and between borings. Between sample runs, sampling equipment was steam-cleaned or washed with Alconox (a non-phosphate detergent) and rinsed with clean tap water. All borings were grouted with neat cement and bentonite to within approximately one foot of ground surface. The upper foot of each boring was backfilled with native material. Soil cuttings generated during drilling were enclosed in plastic sheeting adjacent to the boring. The cuttings were left on-site, pending the results of the chemical analysis to determine their status for disposal.

4.2.2 Chemical Analysis of Soil Samples

Because of the relatively thin soil profile observed in Proposed Housing Areas 1 and 2, analytical testing was limited to near-surface soil samples. Samples of the underlying bedrock were not analyzed. Chemical analysis of the soil samples was performed by Curtis & Tompkins, Ltd. of San Francisco, a laboratory certified by the U.S. Navy and the State of California for hazardous waste analyses. The soil samples were analyzed according to EPA Test Method 8240 for VOCs, EPA Test Method 8270 for SOCs, atomic absorption spectrophotometry for metals, and EPA Test Method 8080 for PCBs. Polarized-light microscopic analysis for asbestos was performed by TMA/Norcal Laboratories of Richmond, California.

HLA's report entitled "Subsurface Investigations, Proposed Housing Areas 1 and 2, Ex-Hunters Point Naval Shipyard, San Francisco, California" is presented in Appendix A. The HLA report includes the laboratory reports, descriptions of analytical methods, quality assurance information, and a list of chemicals with detection limits and measured concentrations.

5.0 CHEMICAL DATA

The analytical results of air and soil samples collected at HPA sites are presented in Sections 5.1 and 5.2, respectively.

5.1 AIR SAMPLING RESULTS

The analytical results of air sample analyses are presented in this Section.

5.1.1 Airborne Chemicals at the Industrial Landfill

Five volatile organic chemicals, three semivolatile organic chemicals, two metals, and asbestos fibers were identified in air samples collected at the Industrial Landfill. Volatile organic chemicals were found consistently in air samples collected at the two sampling stations in the Industrial Landfill area. Semivolatile organic chemicals were not detected in samples collected on September 2, 1987 at either sampling station, but were found in samples collected on September 8, 1987. The concentrations of chemicals in air samples collected are presented in Table 5-1. Xylenes were found at the greatest concentration of the volatile organic compounds detected at 2.18×10^{-3} milligrams per cubic meter (mg/m^3). Diethylbenzene isomers were found at the highest measured level (9.40×10^{-3} mg/m^3) of all airborne chemicals. Iron and aluminum were the only metals detected in air samples and they were each found on only one occasion. Asbestos fibers were present and measured in a single sample, at approximately 1×10^{-2} fibers/cubic centimeter ($fibers/cm^3$). Because an air sample was not collected immediately upwind from the Industrial Landfill, the

Table 5-1. Concentrations of Chemical Substances Detected in Air Samples Collected at the Industrial Landfill

Chemical	Sampling Date	Concentration (mg/m^3) Station L1	Station L2
Volatile Organic Compounds			
dichloromethane	9/02/87	2.20×10^{-4}	4.39×10^{-4}
	9/08/87	nd	nd
ethylbenzene	9/02/87	2.05×10^{-4}	4.09×10^{-4}
	9/08/87	2.85×10^{-4}	2.90×10^{-4}
tetrachloroethene	9/02/87	6.56×10^{-5}	1.24×10^{-4}
	9/08/87	4.87×10^{-4}	1.86×10^{-4}
toluene	9/02/87	8.27×10^{-4}	1.73×10^{-3}
	9/08/87	5.48×10^{-4}	5.58×10^{-4}
xylenes	9/02/87	1.02×10^{-3}	2.18×10^{-3}
	9/08/87	1.43×10^{-3}	1.26×10^{-3}
Semivolatile Organic Compounds			
diethylbenzene isomers	9/02/87	nd	nd
	9/08/87	9.40×10^{-3}	8.94×10^{-3}
triethylbenzene	9/02/87	nd	nd
	9/08/87	6.82×10^{-4}	5.59×10^{-4}
unidentified phthalate	9/02/87	nd	nd
	9/08/87	5.68×10^{-4}	5.81×10^{-4}
Metals			
aluminum	9/02/87	nd	nd
	9/08/87	9.11×10^{-3}	nd
iron	9/02/87	nd	8.99×10^{-4}
	9/08/87	nd	nd
Asbestos			
chrysotile fibers	9/02/87	1.25×10^{-2} fibers/cm^3	nd
	9/08/87	nd	nd

nd - not detected at the detection limits of the analytical instrumentation used

source of chemical contaminants detected in the air may not necessarily be attributed solely to chemical contamination present at the Industrial Landfill site.

5.1.2 Airborne Chemicals at Proposed Housing Area 1

Seven volatile organic compounds and three semivolatile organic compounds were detected in air samples collected at Proposed Housing Area 1. Volatile chemicals were found in samples from both sampling stations. Semivolatile chemicals were detected in two samples collected from Sampling Station 1. No particulate metals or asbestos fibers were detected. The concentrations of organic chemicals identified in air samples from Proposed Housing Area 1 are shown in Table 5-2. Again, xylene was the volatile compound found at the highest level (7.66×10^{-4} mg/m^3) and diethylbenzene isomers represented the highest detected concentration (9.28×10^{-3} mg/m^3) of a semivolatile organic compound. However, xylene at the Control Station was detected at a concentration of 1.3 times the concentration at the proposed housing site. The detection of xylene at a higher concentration at the Control Station would indicate that off-site sources exist which contribute xylene to the ambient air and that it may be impossible to identify xylene any single on-site source of this contaminant. In addition, diethylbenzene was detected in the field travel blank which would suggest laboratory cross-contamination or the presence of contaminants in the sampling tubes as supplied by the manufacturer. In this event, the data for the actual sample is either considered invalid or the concentration observed in the field blank is subtracted from the concentration observed for the

Table 5-2. Concentrations of Chemical Substances Detected in Air Samples Collected at Proposed Housing Area 1

Chemical	Sampling Date	Concentration (mg/m^3) Station 1	Station 2
Volatile Organic Compounds			
2-butanone	9/02/87	ns	nd
	9/18/87	nd	4.23×10^{-4}
trichlorofluoromethane	9/18/87	7.37×10^{-5}	nd
	9/02/87	ns	nd
dichloromethane	9/02/87	ns	2.06×10^{-4}
	9/18/87	3.07×10^{-4}	nd
ethylbenzene	9/02/87	ns	1.92×10^{-4}
	9/18/87	9.53×10^{-5}	1.88×10^{-4}
tetrachloroethene	9/02/87	ns	1.84×10^{-4}
	9/18/87	6.10×10^{-5}	1.20×10^{-4}
toluene	9/02/87	ns	5.52×10^{-4}
	9/18/87	4.40×10^{-4}	4.52×10^{-4}
xylenes	9/02/87	ns	7.66×10^{-4}
	9/18/87	nd	7.50×10^{-4}
Semivolatile Organic Compounds			
diethylbenzene isomers	9/02/87	nd	nd
	9/08/87	9.28×10^{-3}	ns
	9/18/87	nd	1.97×10^{-3}
triethylbenzene	9/02/87	nd	nd
	9/08/87	6.15×10^{-4}	ns
	9/18/87	ns	nd
unidentified phthlate	9/02/87	nd	nd
	9/08/87	5.88×10^{-4}	ns
	9/18/87	ns	nd
Metals	9/02/87	nd	nd
	9/08/87	nd	nd
Asbestos	9/02/87	nd	nd
	9/08/87	nd	nd

nd - not detected at the detection limits of the analytical instrumentation used

ns - no sample collected due to pump failure actual samples, reducing the value detected in the actual sample to a lower concentration.

5.1.3 Airborne Chemicals at Proposed Housing Area 2

Five volatile organic compounds, three semivolatile organic compounds, and aluminum were detected in air samples collected from Proposed Housing Area 2. The chemical data is presented in Table 5-3. Xylenes and diethylbenzene isomers were the compounds from the volatile and semivolatile organic groups measured in the highest concentrations, 5.88×10^{-4} mg/m^3 and 1.08×10^{-2} mg/m^3, respectively. Aluminum was the only metal detected (1.01×10^{-2} mg/m^3) and no asbestos fibers were found in air samples. Similarly for Proposed Housing Area 2, xylene was detected at concentrations less than the Control Station and diethylbenzene was found in the field sample blank. Again, this is indicative of a naturally occurring xylene concentration in the ambient air (as a result of various off-site sources) and that the sample may contain laboratory cross-contamination or contaminants from the manufacturing process which make it difficult to evaluate the actual xylene concentration present in the sample collected.

5.1.4 Airborne Chemicals at the Control Station and in the Field Blanks

Five volatile organic chemicals, three semivolatile organic chemicals, and iron were identified in air samples collected from the Control Station. Of the organic chemicals detected, xylenes and diethylbenzene isomers were found in the highest concentrations, 1.10×10^{-3} mg/m^3 and 9.38×10^{-3} mg/m^3, respectively (Table 5-4). Iron was the only metal detected (9.21×10^{-4}

Table 5-3. Concentrations of Chemical Substances Detected in Air Samples Collected at Proposed Housing Area 2

Chemical	Sampling Date	Concentration (mg/m^3) Station 11	Station 12
Volatile Organic Compounds			
dichloromethane	9/04/87	nd	nd
	9/10/87	nd	ns
	9/18/87	ns	2.05×10^{-4}
ethylbenzene	9/04/87	nd	nd
	9/10/87	nd	ns
	9/18/87	ns	9.53×10^{-5}
tetrachloroethene	9/04/87	nd	nd
	9/10/87	nd	ns
	9/18/87	ns	6.10×10^{-5}
toluene	9/04/87	3.87×10^{-4}	2.31×10^{-4}
	9/10/87	3.39×10^{-4}	ns
	9/18/87	ns	4.40×10^{-4}
xylenes	9/04/87	5.59×10^{-4}	nd
	9/10/87	5.88×10^{-4}	ns
	9/18/87	ns	6.67×10^{-4}
Semivolatile Organic Compounds			
diethylbenzene isomers	9/04/87	6.74×10^{-3}	1.08×10^{-2}
	9/10/87	1.42×10^{-3}	7.06×10^{-3}
triethylbenzene	9/04/87	3.64×10^{-4}	6.99×10^{-4}
	9/10/87	nd	nd
unidentified phthalate	9/04/87	4.04×10^{-4}	6.34×10^{-4}
	9/10/87		
Metals			
aluminum	9/04/87	1.01×10^{-2}	nd
	9/10/87	nd	nd
Asbestos	9/04/87	nd	nd
	9/10/87	nd	nd

nd - not detected at the detection limits of the analytical instrumentation used
ns - not sampled due to pump failure

Table 5-4. Concentrations of Chemical Substances Detected in Air Samples Collected at the Control Station

Chemical	Sampling Date	Concentration (mg/m^3) Control Station
Volatile Organic Compounds		
dichloromethane	9/10/87	nd
	9/18/87	2.04×10^{-4}
ethylbenzene	9/10/87	1.70×10^{-4}
	9/18/87	1.91×10^{-4}
tetrachloroethene	9/10/87	nd
	9/18/87	6.10×10^{-5}
toluene	9/10/87	5.87×10^{-4}
	9/18/87	7.69×10^{-4}
xylenes	9/10/87	1.10×10^{-3}
	9/18/87	1.05×10^{-3}
Semivolatile Organic Compounds		
diethylbenzene isomers	9/10/87	2.20×10^{-3}
	9/04/87	9.38×10^{-3}
triethylbenzene	9/10/87	5.17×10^{-4}
unidentified phthalate	9/10/87	5.38×10^{-4}
Metals		
iron	9/04/87	nd
	9/08/87	nd
	9/10/87	9.21×10^{-4}
Asbestos	9/08/87	nd

nd - not detected at the detection limits of the analytical instrumentation used

mg/m^3) and no asbestos fibers were found in air samples. The concentration of xylene found in the upwind Control Station is greater than that found in Proposed Housing Area 1 and 2.

Field Blank Tenax tubes, XAD-2 tubes, and MCEFs were analyzed for volatile organic compounds, semivolatile organic compounds, and metals, and a field blank MCEF was analyzed for asbestos. A field blank sample is a collection tube or filter apparatus momentarily opened to air in the field and then sealed and transported as other samples. The field blank does not receive air from the sampling pump. Two volatile organic compounds (dichloromethane and trichlorofluoromethane) and one semivolatile organic compound (diethylbenzene) were detected in the field blanks (Table 5-5) which may be indicative of laboratory cross-contamination or combination from the manufacturing process and not representative of the actual concentration present in the sample collected. Dichloromethane was found in similar concentrations at Proposed Housing Areas 1 and 2. Trichlorofluoromethane was also found at Proposed Housing Area 1 and diethylbenzene was found in all samples collected.

5.1.5 Analysis of Air Chemical Data

Maximum chemical concentrations measured in air samples collected from the Industrial Landfill, Proposed Housing Areas 1 and 2, and the Control Station are compared in Table 5-6. There is a distinct similarity in types and concentrations of organic chemicals in the air at these locations. Only 2-butanone and trichlorofluoromethane were found at only one location, Proposed Housing Area 1. Trichlorofluoromethane was detected in the

Table 5-5. Concentration of Chemical Substances Detected in Air Sample Field Blanks

Chemical	Concentration (ug/sample)[a] Sample Blank
<u>Volatile Organic Compounds</u>	
dichloromethane	0.3
trichlorofluoromethane	0.1
<u>Semivolatile Organic Compounds</u>	
diethylbenzene isomers	7.0

a - a field blank is exposed to the air but no air is pumped through the collection apparatus

Table 5-6. Comparison of Maximum Airborne Concentration Data for the Industrial Landfill, Proposed Housing Areas 1, 2, and the Control Station

Chemicals	Concentration (mg/m^3) Industrial Landfill	Housing Area 1	Housing Area 2	Control Station
Volatile Organic Compounds				
2-butanone	nd	4.2×10^{-4}	nd	nd
dichloromethane	4.4×10^{-4}	3.1×10^{-4}	2.0×10^{-4}	2.0×10^{-4}
ethylbenzene	4.1×10^{-4}	1.9×10^{-4}	9.5×10^{-5}	1.9×10^{-4}
tetrachloroethene	4.9×10^{-4}	1.8×10^{-4}	6.1×10^{-5}	6.1×10^{-5}
toluene	1.7×10^{-3}	5.5×10^{-4}	4.4×10^{-4}	7.7×10^{-4}
trichlorofluoromethane	nd	7.4×10^{-5}	nd	nd
xylenes	2.2×10^{-3}	7.7×10^{-4}	6.7×10^{-4}	1.0×10^{-3}
Semivolatile Organic Compounds				
diethylbenzene isomers	9.0×10^{-3}	9.4×10^{-3}	1.1×10^{-2}	2.2×10^{-3}
triethylbenzene	6.8×10^{-4}	6.1×10^{-4}	7.0×10^{-4}	5.2×10^{-4}
unidentified phthalate	5.8×10^{-4}	5.9×10^{-4}	6.3×10^{-4}	5.4×10^{-4}
Inorganic Compounds				
aluminum	9.1×10^{-3}	nd	1.0×10^{-2}	nd
iron	9.0×10^{-4}	nd	nd	9.2×10^{-4}
Asbestos	1.25×10^{-2} fibers/cm^3	nd	nd	nd

nd - not detected at the detection limits of the analytical instrumentation used

field blank. This similarity in compounds and concentrations suggests that the chemicals detected in the air are likely regional in distribution and originate from diverse sources rather than isolated HPA sources.

The organic chemicals detected in air samples collected at the HPA are common and ubiquitous in urban environments as evidenced by data summarized in Verschueren (1983) (Table 5-7). The concentrations of these chemicals in air collected from Proposed Housing Areas 1 and 2 are below the range of reported levels for urban environments in such cities as Washington, D.C. and Los Angeles. In addition, dichloromethane, trichlorofluoromethane, and diethylbenzene appear in the sample blanks at similar concentrations to those in most of the samples.

Iron and aluminum are common metals in silicate materials. Concentrations of these metals in airborne particles appear to be within normal limits for the San Francisco area based on data for silicate levels in suspended particulates from studies by the Bay Area Air Quality Management District (Levaggi et al., 1976). Their data showed an approximate weight ratio of silicon to iron and aluminum of five to ten respectively. Based on average airborne silicate levels of 5.7×10^{-3} mg/m^3 to 2.3×10^{-2} mg/m^3 and maximum airborne silicate levels of 1.9×10^{-2} mg/m^3 to 6.5×10^{-2} mg/m^3 for San Francisco Bay Area locations, iron and aluminum concentrations of 10^{-2} to 10^{-4} mg/m^3 measured in HPA air samples are not unusual.

Table 5-7. Range of Concentrations of Volatile Organic Chemicals Measured in Air Samples from Urban Areas in the United States

Chemical	Concentration[a] (mg/m^3)
2-butanone	b
dichloromethane	1.8×10^{-2}
diethylbenzene	c
ethylbenzene	8.7×10^{-3} - 8.7×10^{-2}
tetrachloroethene	6.9×10^{-4} - 2.9×10^{-3}
toluene	3.8×10^{-2} - 1.9×10^{-1}
trichlorofluoromethane	7.9×10^{-4} - 1.2×10^{-2}
triethylbenzene	c
xylene	4.4×10^{-2} - 1.9

a concentration values taken from the Handbook of Environmental Data on Organic Chemicals (Verschueren, 1983).

b 2-butanone is a common solvent and also a component of gasoline exhaust. No data is presently available on expected ambient airborne concentrations.

c diethylbenzene and triethylbenzene are constituents of gasoline and are expected to be found in urban air. However, no quantitative data is presently available on expected ambient airborne concentrations.

5.2 SOIL SAMPLING RESULTS

The range of chemical concentrations measured in soil samples collected from Proposed Housing Areas 1 and 2 is summarized in Table 5-8. Only metals and asbestos were detected in soil samples at these sites. Chromium and nickel are the metals detected at the highest levels, 884 mg/Kg and 2,500 mg/Kg, respectively. However, the levels of all metals measured appear to be within the normal range for serpentinite type soils. A report on the geology of San Francisco indicated that chromium concentrations of 700 mg/Kg and nickel concentrations of 3,000 mg/Kg are common in serpentine material (Schlocker, 1978). Towill et al. (1978), reported natural chromium concentrations of about 1,800 mg/Kg in serpentine materials. Nickel content in soil over serpentine rock may be as high as 7,000 mg/Kg (Kabata-Pendias and Pendias, 1984). Serpentine is also the natural source of chrysotile asbestos fibers. Serpentine is common in the coastal range in California and is present at Proposed Housing Areas 1 and 2.

The analytical data for soil samples indicates that soils from Proposed Housing Areas 1 and 2 are not contaminated and that their chemical composition is normal for soils derived from serpentinite materials.

5.3 CHEMICAL SUBSTANCES CONSIDERED IN THE RISK ASSESSMENT

No organic chemical substances, metals, or asbestos were detected above background levels in soil samples collected from the Proposed Housing Areas 1 and 2. Although asbestos was present in soil samples collected, based upon the air sample analytical results, asbestos

Table 5-8. Range of Concentrations of Chemical Substances Detected in Soil Samples Collected from Proposed Housing Areas 1 and 2

Chemical	Concentration (mg/Kg) Housing Area 1	Housing Area 2
<u>Metals</u>		
arsenic	nd	nd
antimony	nd	nd
barium	8.0-77	3.6-218
beryllium	nd	nd
cadmium	nd	nd
chromium	124.0-552	74.0-884
cobalt	66.2-160	39.0-136
copper	6.0-16.6	4.2-48
lead	48	nd
mercury	0.08	nd
molybdenum	nd	nd
nickel	178.0-2500.0	50.6-2070.0
selenium	nd	nd
silver	nd	nd
thallium	nd	nd
vanadium	17.4-58.4	31.8-78.4
zinc	14.8-66.8	15.0-46.0
<u>Asbestos</u> (percent)	nd - <1	nd - 10
Volatile <u>Organic Compounds</u>	nd	nd
Semivolatile <u>Organic Compounds</u>	nd	nd

nd - Not detected at the detection limits of the analytical instrumentation used. (See certified laboratory reports, Appendix C, for detection limits) was not airborne and therefore not considered to present any potential health risks. Similarly, only iron and aluminum, natural constituents of silicate materials, were detected in air samples collected. Consequently, neither asbestos or metals were evaluated in this risk assessment.

The only chemicals considered for the risk assessment were the airborne chemicals identified in Tables 5-2 and 5-3. The only specific indicator chemical (chemical which may pose the greatest health risk) which was identified was 2-butanone. Other airborne chemicals which also were found at the Control Station at similar or higher concentrations included:

- o ethylbenzene
- o tetrachloroethene
- o toluene
- o xylenes

Diethylbenzene and triethylbenzene are not included as indicator chemicals since there is very little data available on the health effects or environmental consequences of these compounds. In addition, these chemicals were found in the field blanks so that their presence is questionable. The environmental behavior and toxicity of diethylbenzene and triethylbenzene is assumed to be similar to that of ethylbenzene which is included as an indicator chemical for the risk assessment.

Trichlorofluoromethane will not be considered in the risk assessment since it was detected in only one sample and was found at the same time in the field blank sample. Similarly, dichloromethane was found in all samples collected at similar concentrations including the field blank and the Control Stations.

A generic phthalate compound was detected in air samples collected. However, because the individual chemical species was not identified and toxicity information is available for specific phthalate compounds only, phthalates will not be considered in the risk assessment.

Contamination in the field blanks is possibly indicative of laboratory cross-contamination or the presence of residual contaminants in the sorbert tubes, as supplied by the manufacturer. The presence of chemical constituents in samples collected at the Control Station indicates that off-site sources may be contributing to the concentration of airborne chemical constituents at HPA.

6.0 TOXICOLOGY OF INDICATOR CHEMICALS

Although the airborne concentrations of chemicals detected with any HPA source or to be at levels unusual for urban air, health effects associated with exposure to these chemicals were reviewed as a basis for assessing the potential risk associated with inhalation of these compounds at Proposed Housing Areas 1 and 2. A short summary of health effects data is presented below and a more detailed summary of toxicological information is presented in Appendix E.

6.1 2-BUTANONE (METHYL ETHYL KETONE)

2-Butanone is a common solvent. Absorption of inhaled 2-butanone from the lungs can be inferred from the toxic effects observed after acute and subchronic exposures.

Subchronic inhalation exposures of rats to 200 ppm (588 mg/m^3) 2-butanone produced slight neurological effects (Takeuchi et al., 1983). Exposures of 2,500 ppm (7,350 mg/m^3) 2-butanone increase the weight of the liver in rats (Cavender et al., 1983). Schwertz et al. (1974) concluded that in rats 2-butanone was embryotoxic, fetotoxic, and potentially teratogenic at exposure levels of 1,000 ppm (2,940 mg/m^3) by inhalation. No data are available regarding the carcinogenicity of 2-butanone in humans or animals and the chemical is most appropriately classified as a Group D - Not Classified chemical.

The acceptable intake subchronic (AIS) for inhalation of 2-butanone has been calculated to be 2.19 mg/Kg/day or 153.4 mg/day for a 70 Kg human (EPA 1984a). The acceptable intake chronic (AIC) for inhalation of

2-butanone has been calculated to be 0.219 mg/Kg/day or 15.3 mg/day for a 70 Kg human (EPA 1984a).

6.2 ETHYLBENZENE

Ethylbenzene is a common product of petroleum refining. Bardoaej and Bardodejova (1970) were able to determine that human volunteers absorbed 64 percent of the total ethylbenzene to which they were exposed through inhalation at dose levels ranging from 100 to 300 mg/m^3.

The target organs of acute ethylbenzene exposure are the lungs and central nervous system (Smyth et al., 1962; Faustov, 1958; Faustov, 1960). The main effects of subchronic and chronic inhalation exposures of ethylbenzene to animals appeared in the liver and kidneys (Wolf et al., 1956) and included an increase in hepatic and renal weight accompanied by cloudy swellings of hepatocytes and renal tubular epithelial cells. Slight testicular degeneration was also noted in rabbits and monkeys (Wolf et al., 1956). Several animal studies have suggested that ethylbenzene has some teratogenic effects (Hardin et al., 1981). No data exists on the carcinogenic effects of ethylbenzene on humans. Ethylbenzene is classified as a Group D - Not Classified chemical (EPA, 1984c).

The maximum dose of ethylbenzene tolerable for subchronic and chronic exposures to humans has not been derived by the EPA (EPA, 1984c). Harris (1983) estimated a minimum effective dose (MED) of 724 mg/day based on an effect of increased liver and kidney weight in exposed rats.

6.3 TETRACHLOROETHENE (PCE)

Tetrachloroethene is a commonly used solvent. Tetrachloroethene absorption via the lungs is rapid, and the amount of tetrachloroethene absorbed at a given vapor concentration (for exposure of greater than eight hours) is directly related to the respiratory volume of air inhaled (Hake and Stewart, 1977).

Human health effects as a result of chronic inhalation exposure to various concentrations of tetrachloroethene include respiratory tract irritation, nausea, headache, sleeplessness, abdominal pains, and constipation (Chmielewski et al., 1976; Coler and Rossmiller, 1953; Stewart et al., 1970; von Oettingen, 1964). Liver cirrhosis, hepatitis, and nephritis have also been reported (Stewart, 1969).

The effects of subchronic inhalation exposure to tetrachloroethene have been examined in rats, mice, rabbits, guinea pigs, and monkeys. Adverse effects of tetrachloroethene exposure included renal and splenic congestion and reduced hepatic glycogen storage. A NOEL of 70 ppm (482 mg/m^3) tetrachloroethene for hepatic, renal, and splenic pathologic changes in rats can be derived (Carpenter, 1937). A LOAEL of 100 ppm (689 mg/m^3) tetrachloroethene for hepatic effects in guinea pigs can be derived from a study by Rowe et al. (1952).

The teratogenicity of tetrachloroethene was shown in a study by Schwetz et al. Maternal rats had a statistically significant reduction in mean body weight while maternal mice had increased mean relative liver weight. The fetal body weight of mice was significantly depressed. A significantly increased number of rat fetuses were resorbed. For mice, the incidences of subcutaneous edema, delayed ossification of skull bones, and split sternebrae were significantly increased compared with the incidence of the effects in control mice.

In a study of 330 deceased laundry and dry-cleaning workers with a history of exposure to tetrachloroethene, carbon tetrachloride, and trichloroethylene, Blair et al., (1979) observed an excess of lung, cervical, and skin cancer and a slight excess of leukemias and liver cancers.

In 1985, tetrachloroethene was classified according to EPA criteria as a Group C - Possible Human Carcinogen based on the limited evidence of carcinogenicity in animals, and inconclusive evidence from epidemiologic studies (EPA, 1985b). In 1986 EPA proposed an upgrade in the classification of tetrachloroethene to a Group B2 - Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans (EPA, 1986b). According to EPA's guidelines for selection of indicator chemicals, those chemicals ranked B2 are generally not selected as indicator chemicals (EPA, 1986b).

The carcinogenic potency (q_1*) has been calculated for oral tetrachloroethene exposure. It is estimated to be 3.9776×10^{-2} $(mg/Kg/day)^{-1}$. A q_1* value for inhalation exposures could not be derived due to lack of a controlled study where an increase in tumor incidence was demonstrated following inhalation exposure to tetrachloroethene (EPA, 1984d). A range of unit risk values, 2.9 to 7.5×10^{-7} $(ug/m^3)^{-1}$, have been estimated for life-time inhalation exposures to one ug/m^3 tetrachloroethene (EPA, 1986). Any use of the risk estimates should include a recognition of the weight-of-evidence likelihood of tetrachloroethene's carcinogenic potential in humans. We have evaluated PCE as a carcinogen simply because of the availability of the q* and as a worst-case scenario. This substance is not considered a state carcinogen by the Scientific Advisory Panel for Proposition 65 carcinogen identifications.

6.4 TOLUENE

Toluene is a major component of gasoline and is also used as a solvent. In humans, studies have shown that the percentage of toluene absorbed two to four hours after the start of exposure was 37 percent of the inspired dose (Nomiyama and Nomiyama, 1974).

The effects of chronic toluene exposures to humans have been widely studied due to toluene's widespread use in the workplace. For mean exposure levels greater than 200 ppm, all of the available studies except that of Suhr (1975) report some evidence of neurologic effects. Reports of headache, nausea, and concentration related impairment of coordination (Wilson, 1943) are consistent with the relatively well-documented central nervous system effects of single exposures to toluene (reviewed in EPA, 1984e).

Subchronic inhalation studies of toluene in animals indicate that female rats are more sensitive to toluene than male rats (Ungvary et al., 1980). At toluene exposures of 1,000 mg/m^3 female rats showed changes in liver weight and body weight as well as an increase in cytachrome P-450 level. Toluene was not found to be fetotoxic or teratogenic in rats at a level of 1,000 ppm (3,830 mg/m^3) (Shigeta et al., 1982).

No pertinent data were found regarding the carcinogenicity of toluene to humans following inhalation exposures. A chronic bioassay of toluene in Fisher 344 rats of both sexes showed no carcinogenic effects (CIIT, 1980). Toluene is classified as a Group D - Not Classified chemical according to EPA criteria (EPA, 1984e).

The AIS of toluene tolerable through oral uptake is 30 mg/day and through inhalation is 104 mg/day for a 70 Kg human. The AIC for toluene through oral uptake is 20 mg/day and through inhalation is 41 mg/day for a 70 Kg human (EPA, 1984e).

6.5 XYLENE

Xylene is a common constituent of gasoline. It can exist in three isomeric forms with commercial xylene being a mixture of the three. Studies evaluating the inhalation absorption rate in humans exposed to doses ranging from 100 to 1,300 mg/m^3 indicated that approximately 60 percent of the xylene present in inspired air, regardless of the isomer or isomer mixture used, is absorbed (Astrand et al., 1978; Riihimaki et al., 1979).

In male rats exposed to high xylene dose (3,500 mg/m^3), an increase in erythrocyte and monocyte counts was noted (Carpenter et al., 1985). These effects disappeared after the seventh week of testing. A decrease in brain superoxidase dismatase was noted in another study of rats exposed to 1,300 mg/m^3 xylene. Rats also recovered from this effect (Savolainen et al., 1979). Chronic xylene inhalation by rats led to an increase in food uptake without subsequent gain in body weight (Tatrai et al., 1981).

Teratogenic effects were noted at high dose levels of xylene inhalation. Continuous exposure through inhalation of 26 pregnant rats to a 1,000 mg/m^3 xylene - ethylbenzene mixture in a ratio of four to one on days nine to 14 of gestation resulted in increased incidence of fused sternebrae and extra ribs and of retarded skeletal development of offspring. At higher dosages maternal food consumption and weight decreased while resorptions of fetuses increased (Hudak and Ungvary, 1971).

No human epidemiological data or animal bioassay data exist to indicate that xylene is a carcinogen. Xylene is classified as a Group D - Not Classified chemical according to EPA criteria (EPA, 1984f).

The AIS for xylene oral exposure was calculated to be 7.0 mg/day for a 70 Kg human. AIS via inhalation exposure was calculated to be 325.0 mg/day for a 70 Kg human. The AIC for oral and inhalation exposure was calculated to be 0.7 mg/day and 82.33 mg/day, respectively (EPA, 1984f).

7.0 RECEPTOR POPULATIONS

Present and future residents of Proposed Housing Areas 1 and 2 constitute the population of receptors most likely to be exposed to the airborne chemicals previously identified. There are presently three families residing in Proposed Housing Area 2; no individuals reside in Proposed Housing Area 1. The projected size of populations using these two areas after housing has been developed and occupied is 750 for Area 1, and 505 for Area 2. The number of construction workers involved in building houses at these locations cannot presently be estimated but should be less than 500 at any one point in time.

The composition of these receptor populations is presently unknown and cannot be characterized. Therefore, the following assumptions are made to better characterize potential residents for the Proposed Housing Areas 1 and 2:

- The housing units will be occupied by military families. Most adults are expected to be young or middle aged, and a large number of families are expected to have children;

- Few older individuals are expected to reside in the housing units;

- Pregnant women and children are likely to be the most sensitive population subgroups;

- The lengths of residency for individuals is expected to be short, perhaps two to three years and generally less than five years.

For preliminary characterization of health risks associated with long-term contaminant exposures, the receptor population is assumed to be composed of a 70 Kg adults who breathe 20 cubic meters (m^3) of air daily. Lifetime exposures are assumed for chronic effects and carcinogenicity although receptors are expected to live in the housing areas for less than five years. The above exposure parameters will provide a very conservative approach to addressing health risks.

8.0 EXPOSURE PATHWAYS

The absence of chemicals above background in soils at the proposed housing areas eliminated the possibility of human exposures to chemicals from dermal contact with or ingestion of soil. All domestic water will be provided by the City of San Francisco. Therefore, there is no possibility of site-related chemical exposure through drinking water ingestion or dermal contact with supplied water.

The only potential exposure route for receptors is inhalation of airborne chemicals transported to the site from unknown regional sources. Inhalation is the only route of exposure considered in the further characterization of health risks.

During remediation activities for IR sites and excavation activities at proposed housing areas, it is expected that necessary precautions will be taken to inhibit the airborne release of soils which may contain toxic substances.

9.0 EXPOSURE POINT CONCENTRATIONS

To properly characterize potential exposure concentrations associated with possible releases of chemicals, measured chemical concentration data and environmental fate modeling are generally used to estimate peak short-term concentrations and long-term average concentrations for critical exposure points.

No known specific chemical sources have been identified for the volatile and semivolatile organic chemicals detected in air samples collected at Proposed Housing Areas 1 and 2. The most likely sources are due to urbanization and petroleum utilization. Thus, critical exposure point concentrations are best estimated from measured chemical concentration data.

Air sampling at Proposed Housing Areas 1 and 2 was conducted under dry windy summer conditions. These conditions are considered to be near optimal for both particulate emissions and volatile releases of chemicals to the atmosphere. For exposure characterization, it was assumed that the concentrations of chemicals measured in air under such conditions are representative of maximum annual average levels and that peak short-term concentrations are equivalent to approximately 100 times the measured levels. Estimated maximum annual average and peak concentrations for indicator chemicals are presented in Table 9-1.

These exposure point concentrations will be used to characterize potential risks of health effects from long and short-term peak exposures.

Table 9-1. Estimated Maximum Annual Average and Peak Concentrations of Indicator Chemicals in Air at Proposed Housing Areas 1 and 2

Chemical	Annual Average Concentrations (mg/m^3)	Short-Term Peak Concentrations (mg/m^3)
2-butanone	4.2×10^{-4}	4.0×10^{-2}
ethylbenzene	1.9×10^{-4}	2.0×10^{-2}
tetrachloroethene	1.8×10^{-4}	2.0×10^{-2}
toluene	5.5×10^{-4}	5.5×10^{-2}
xylene	7.7×10^{-4}	8.0×10^{-2}

10.0 RISK CHARACTERIZATION

The following three approaches are used in this risk assessment to screen potential health risks from airborne chemical exposures:

- Maximum annual average concentrations are compared to acceptable environmental concentrations derived from Threshold Limit Values - Time-Weighted Averages (TLV-TWA), and peak concentrations are compared to Threshold Limit Values - Short-Term Exposure Limit Values (TLV-STEL).

- Maximum annual average daily doses are compared to acceptable chronic intake levels estimated by the EPA.

- Maximum annual average concentrations are used to calculate carcinogenic risk based on unit risk values for tetrachloroethene.

10.1 RISK BASED ON THRESHOLD LIMIT VALUES

Threshold Limit Values are developed by the American Conference of Governmental Industrial Hygienists (ACGIH), and published as "TLVs for Chemical Substances and Physical Agents in the Work Environment" (ACGIH, 1986). A TLV-TWA represents an eight-hour, time-weighted average concentration of a chemical in air. TLVs are intended as guidelines to protect workers from various adverse health effects over a normal working lifetime.

For purposes of assessing the potential health impacts from this project, the TLVs have been adjusted to reflect assumptions that a person living in Proposed Housing Areas 1 and 2 could have continuous exposure (24-hours per day, seven days per week), whereas, a normal worker's exposure is assumed to be only eight hours per day, five days per week. An average inhalation rate of 20 cubic meters of air per day is assumed rather than the 10 cubic meters of air assumed to be inhaled in developing the TLV levels for an eight-hour work day. It is assumed that the inhalation rate is greater during the eight-hour work day than after hours, particularly during sleep. This is the reason that the average inhalation rate is assumed to be 20 cubic meters of air per day rather than 24.

Chronic exposure screening levels (those levels estimated through the extrapolations of TLV criteria to 24-hour continuous exposure) are shown in Table 10-1 for the indicator chemicals. Table 10-2 compares the annual average concentration with the screening level TLV. The Table 10-2 data shows the exposure level at the housing sites is four orders of magnitude less than the permissible level for chronic exposures based on TLV-TWA values.

If chronic exposures to individual compounds are assumed to be additive, the risk from potential exposure to the mixture of noncarcinogenic airborne contaminants can be estimated as:

$$\text{RISK} = \frac{C_1}{AL_1} + \frac{C_2}{AL_2} + \ldots + \frac{C_i}{AL_i}$$

Table 10-1. Screening Criteria Based on Threshold Limit Values

Chemical	TLV-TWA[a] (mg/m^3)	Screening Level[b] Based on TLV (mg/m^3)	TLV-STEL[c] (mg/m^3)
2-butanone	590	7.1	885
ethylbenzene	435	5.2	545
tetrachlorethene	na		na
toluene	375	4.5	560
xylene	435	5.2	655

a - Threshold Limit Value (TLV) is the Time-Weighted Average concentration for a normal 8-hour workday and 40-hour workweek (ACGIH, 1986).

b - TLVs are adjusted to develop screening levels by the following formula:

$$\text{TLV} \times \frac{8 \text{ hours}}{24 \text{ hours}} \times \frac{5 \text{ day}}{7 \text{ days}} \times \frac{10m^3/\text{day}}{20m^3/\text{day}} \times \frac{1}{100}$$

where $\frac{1}{100}$ is an uncertainty factor

c - Short-Term Exposure Limit (ACGIH, 1986)

na - TLV criteria value is not available

Table 10-2. Comparison of Projected Concentrations with Screening Criteria Based on Threshold Limit Values

Chemical	Maximum Annual Average Concentration (mg/m^3)	Screening TLV (mg/m^3)	Peak Concentration (mg/m^3)	TLV-STEL (mg/m^3)
2-butanone	4.2×10^{-4}	7.1	4.0×10^{-2}	885
ethylbenzene	1.9×10^{-4}	5.2	2.0×10^{-2}	545
toluene	5.5×10^{-4}	4.5	5.5×10^{-2}	560
xylene	7.7×10^{-4}	5.2	7.7×10^{-2}	655

WHERE

C_i = maximum annual average concentration for the i^{th} chemical

AL_i = maximum acceptable level for the i^{th} chemical

A calculated risk level less than one would indicate a negligible risk from exposure to the mixture. The total calculated level of risk from exposure to a mixture of 2-butanone, ethylbenzene, toluene, and xylene is 3.64×10^{-4}. The calculated sum of risk from multiple chemical exposure is substantially less than one.

Short-Term Exposure Limit (TLV-STEL) values are concentrations that should not be exceeded for exposures of 15 minutes and should not be repeated more than four times per day, with at least 60 minutes between excessive exposures (ACGIH, 1986). TLV-STEL values are presented in Table 10-1.

Table 10-2 also compares the peak concentrations for chemicals with the TLV-STEL; the exposure levels at the housing sites is four orders of magnitude less than the permissible levels for acute exposures.

Based on the above analysis, the airborne chemicals found at the site do not appear to pose a risk based on the TLV derived analysis.

10.2 RISK BASED ON ACCEPTABLE CHRONIC INTAKE VALUES

Minimum effective dose (MED - lowest dose required to initiate any measurable adverse effects) and AIC criteria values for indicator chemicals are shown in Table 10-3. AIC values are only available for

Table 10-3. Comparison of Estimated Maximum Annual Average Concentration with Screening Criteria Based on Minimum Effective Dose and Maximum Acceptable Intake Chronic Values

Chemical	Minimum Effective Dose (MED) (mg/day)	Maximum[a] Acceptable Intake Chronic (AIC) (mg/day)	Maximum[b] Annual Average Daily Dose (mg/day)
2-butanone	na	15.3	8.4×10^{-3}
ethylbenzene	724	na	3.8×10^{-3}
tetrachloroethene	na	na	3.6×10^{-3}
toluene	4,036	41	1.1×10^{-2}
xylene	na	82.33	1.5×10^{-2}

a - data from citations presented in Section 6.
b - maximum annual average daily dose equals maximum annual average concentration times the volume of air inhaled daily (20 m^3/day).
na - criteria value not available.

2-butanone, toluene, and xylene. MED criteria are available for ethylbenzene and toluene. These criteria values are compared in Table 10-3 to estimated maximum annual average daily dose values estimated by multiplying maximum annual average concentration values by the volume of air inhaled daily (20 m^3/day).

Estimated maximum annual average daily dose values are four orders of magnitude less than the AIC criteria values and six orders of magnitude less than MED criteria. A sum of risk for individual chemicals is substantially less than one, therefore, the airborne chemicals do not appear to pose a risk based on acceptable chronic intake or minimum effective dose criteria values.

10.3 RISK ASSESSMENT FOR POTENTIAL CARCINOGENIC COMPOUNDS

Of the list of indicator chemicals presented in Section 5, tetrachloroethene was the only compound identified as a potential carcinogen in this risk assessment. Tetrachloroethene (EPA 1986) has been identified as a Group B2-Animal Carcinogen with inadequate evidence of carcinogenicity in humans. Potential carcinogenic risk is estimated by multiplying the unit risk value for the chemical by the estimated maximum annual average concentration. The unit risk value is defined as a lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed continuously from birth throughout their lifetime to a concentration of one microgram per cubic meter (ug/m^3) of the particular chemical in the air they breathe. Unit risk estimates are used to compare the carcinogenic potency of several agents with each other and to provide an indication of the potential risk to a receptor population which might be associated with air exposure to these chemicals at a specified dose (exposure) level. The data used to derive these quantitative unit risk estimates are taken from animal bioassay experiments selected by the EPA's Cancer Assessment Group (CAG). It is assumed that if a carcinogenic response occurs at high dose levels used in the study, then responses would occur at all lower doses at an incidence determined by an extrapolation model. It should be noted that such low levels of risks cannot be measured directly either by animal experiments or by human epidemiological studies. Therefore, the CAG has adopted a linear, non-threshold model as the basis for risk extrapolation to lower levels of the dose-response relationship. The risk estimates made with this model are regarded as conservative and represent the most plausible upper limit of the risk (Federal Register, November 28, 1980).

The equation used to derive the unit risk estimate is a linearized, multi-stage model. The model incorporates a procedure for estimating the largest possible linear slope (upper 95 percent confidence limit) at low extrapolated doses that is consistent with the data of all dose levels of the experiment.

The unit risk estimates determined by the CAG for tetrachloroethene are shown in Table 10-4. The unit risk estimate are taken from recent Addendums to the Final Health Assessment Documents published by the EPA Office of Health and Environmental Assessment, Washington (EPA, 1986b). The unit risk estimates are calculated by CAG.

Table 10-4. Calculated Lifetime Risk Levels for Possible Carcinogenic Compounds Based on Unit Risk Values and Maximum Annual Average Concentrations

Chemical	CAG Unit Risk Value $(ug/m^3)^{-1}$	Annual Maximum Average Concentration (ug/m^3)	Calculated Lifetime Risk Level
tetrachloroethene	2.9×10^{-7}[a] 9.5×10^{-7}[b]	1.8×10^{-1}	5.2×10^{-8} 1.7×10^{-7}

a - Unit risk values from the March 1986 Draft Addendum to the EPAs Health Effects Assessment Document for tetrachloroethene (EPA 600/8-82/005F). A range of values were published based upon several separate studies.

The calculated lifetime cancer risk estimates for individual exposure to tetrachloroethene is shown in Table 10-4. The calculated cancer estimate for tetrachloroethene is an incidence of less than one excess cancer in 10 million (1×10^{-7}) individuals exposed for a lifetime to 1.0 ug/m^3.

The cancer risk estimates indicate that the risk of cancer from exposure to estimated maximum annual average concentrations of tetrachloroethene is within the acceptable risk level established as policy by the EPA and the California Department of Health Services (DHS). The acceptable risk level is one excess cancer in a population of one million exposed individuals (1×10^{-6}). Therefore, exposures to tetrachloroethene at Proposed Housing Areas 1 and 2 are below the acceptable risk levels. This estimate is based on a worst-case scenario in assuming that tetrachloroethene is ranked as a potential human carcinogen. To date, there is inadequate evidence to rank tetrachloroethene as a human carcinogen.

11.0 HUMAN HEALTH RISK ASSESSMENT SUMMARY

Three possible exposure pathways were examined for receptors at Proposed Housing Areas 1 and 2:

- o Dermal contact with soils which may contain chemicals at these sites;
- o Ingestion of soil that may contain chemicals at these sites;
- o Inhalation of airborne chemicals from local or regional sources.

Exposure by ingestion of drinking water was not considered possible as potable water for Proposed Housing Areas 1 and 2 will be supplied by pipeline from the City of San Francisco sources.

Metal concentrations in soil did not exceed background levels for serpentine soil. No organic chemicals were found in soil samples from Proposed Housing Areas 1 and 2, therefore, no probability of dermal contact with or soil ingestion of chemicals exists at these sites.

Seven volatile and three semivolatile organic compounds were found in air samples collected in concentrations either similar to or less than background or upwind concentrations. Aluminum and iron were found at low concentrations in air samples collected above the former industrial landfill. However, iron was also found at a similar concentration in an upwind sample. The only chemical found at one of the proposed housing sites which was not found in the field blanks or in the background sample was 2-butanone. This chemical is commonly used in the laboratory and may have occurred in the sample as a result of laboratory handling of the sample. In general, the chemicals detected in air samples are normal for urban areas and may not necessarily be associated with potential sources from HPA.

The risk characterization of selected chemicals found in air samples at the proposed housing sites as well as in background air samples indicated an acceptable exposure risk for humans residing in the Hunters Point area. Therefore, the exposure risk is no greater for future occupants of the proposed housing sites than for residences located upwind of HPA.

Five indicator chemicals were selected to characterize human health risks from potential inhalation to measured chemicals in air samples. The selected indicator chemicals were 2-butanone, ethylbenzene, tetrachloroethene, toluene, and xylene. Of these chemicals, tetrachlorethene was identified as a B2 Class carcinogen by CAG. This implies limited evidence of carcinogenicity in humans. Although EPA (1986b) has recommended not using a B2 chemical as indicator chemicals, we have selected it as a worst-case scenario. The remaining indicator chemicals are classified as noncarcinogens.

Trichlorofluoromethane and dichloromethane were not considered as indicator chemicals because they were detected in the field blank. Diethylbenzene and triethylbenzene were not considered as indicators as they are not well characterized toxicologically and are believed to act similarly to ethylbenzene which was selected as an indicator. The unidentified phthalate compound detected in air samples also was not included in the indicator list due to a lack of certainty as to its chemical identity. Aluminum and iron detected with airborne particulates are common metals in silicate soils. Concentrations of these metals were at ambient levels for the San Francisco Bay Area and were also not considered in characterizing potential human health risks.

To characterize human health risks from potential inhalation exposures the following three screening approaches were used:

- Maximum annual average concentrations of indicator chemicals were compared to acceptable human exposure concentrations derived from Threshold Limit Values - Time-Weighted Averages (TLV-TWA) and peak concentrations were compared to Threshold Limit Values - Short-Term Exposure Limit Values (TLV-STEL).

- Maximum annual average daily doses of indicator chemicals were compared to acceptable chronic intake levels estimated by the EPA.

- Maximum annual average concentrations were used to calculate carcinogenic risk based on unit risk values for tetrachloroethene.

Estimated annual average concentrations were four orders of magnitude less than the calculated TLV-TWA permissable levels for chronic exposures to indicator chemicals. Therefore, the airborne chemicals found in the samples collected do not pose a health risk based on

TLV analysis. In addition, these chemicals were found in upwind (Control Station) samples.

Estimated annual average daily dose levels of indicator chemicals were four orders of magnitude less than AIC criteria values. Therefore, the chemicals found in air samples collected at Proposed Housing Areas 1, 2, and the Industrial Landfill do not pose a risk based on an analysis of acceptable chronic intake values.

The calculated lifetime cancer risk level for tetrachloroethene is an incidence of less than one excess cancer in 10 million individuals (1×10^{-7}) exposed. The analysis of carcinogenic risk indicates that there is a negligible risk (less than 1×10^{-6}) of cancer associated with expected maximum lifetime exposures to the chemicals in air in the general area of HPA. This chemical was found in the upwind Control Station in similar concentrations as in Proposed Housing Areas 1 and 2.

This risk assessment shows that there is negligible potential human health risk associated with the development and occupation of HPA Proposed Housing Areas 1 and 2. The potential human health risk for exposure to the chemicals found at HPA is no greater than other urban areas of the San Francisco Bay Area.

12.0 REFERENCES

ACGIH. 1986. Documentation of the Threshold Limit Values and Biological Exposure Indices, Fifth Edition. American Conferences of Governmental Industrial Hygenists. Cincinnati, OH.

Astrand, I., J. Engstrom and P. Ovrum. 1978. Exposure to xylene and ethylbenzene, I. Uptake, distribution and elimination in man. Scand. J. Work Environ. Health. 4(3):185-194.

ATT. 1987. Preliminary Public Health and Environmental Evaluation Naval Station Treasure Island Hunters Point Annex. Prepared by Aqua Terra Technologies, Inc., Walnut Creek, California.

Bardodej, F. and E. Bardodejova. 1970. Biotransformation of ethylbenzene, styrene, and alpha-methylstyrene in man. Am. Ind. Hyg. Assoc. J. 31(2):206-209.

Blair, A., P. Decoufle and D. Grauman. 1979. Causes of death among laundry and dry cleaning workers. Am. J. Publ. Health. 69:508-511.

Bonilla, M.G. 1971. Preliminary Geologic Map of the San Francisco Quadrangle and Part of the Hunters Point Quandrangle, California: U.S. Geological Survey Misc. Field Studies Map.

Burek, J.D., K.D. Nitschke, T.J. Bell, et al., 1980. Methylene Chloride: A Two-Year Inhalation Toxicity and Oncogenicity Study in Rats and Hamsters. Final Report. Toxicology Research Laboratory, Health and Environmental Sciences, Dow Chemical USA, Midland, MI 48640. Co-sponsored by Diamond-Shamrock Corp., Dow Chemical Co., Imperial Chemical Industry Ltd., Stauffer Chemical Co., and Vulcan Materials Co.

CARB. 1984. California Surface Wind Climatology. State of California Air Resources Board Aerometric Data Division. Sacramento, California.

Carpenter, C.P. 1937. The chronic toxicity of tetrachloroethylene. Ind. Hyg. Toxicol. 9:323-336.

Carpenter, C.P., E.R. Kinkead, D.L. Geary, Jr., L.J. Sullivan and J.M. King. 1975. Petroleum hydrocarbon toxicity studies. V. Animal and human response to vapors of mixed xylenes. Toxicol. Appl. Pharmacol. 33(3):543-558.

Cavender, F.L., H.W. Casey, Salem, J.A. Swenberg and E. J. Garalla. 1983. A 90-day vapor inhalation toxicity study of methylethylketone. Fund. Appl. Toxicol. 3(4): 264-270.

Chmielewski, J., R. Tomaszewski, P. Glomkiowski, et al., 1976. Clinical observations of the occupational exposure to tetrachloroethylene. Bull. Inst. Marit. Trop. Med. Gdynia. 27(2):197-205.

CIIT. 1980. A Twenty-four Month Inhalation Toxicology Study in Fisher-344 Exposed to Atmospheric Toluene Chemical Institute of Toxicology.

Coler, H.R. and H.R. Rosemiller. 1953. Tetrachloroethylene exposure in a small industry. Ind. Hyg. Occup. Med. 8:227.

EMCON. 1987. Confirmation Study Verification Step., Hunters Point Naval Shipyard, San Francisco, California. March 19, 1987.

Engineering Science. 1986. Volumes 1 and 2: Air Toxics Source Assessment Manual for California Air Pollution Control Districts. Engineering-Science, Berkeley, California.

EPA. 1984a. Health Effects Assessment for Methylethylketone. EPA/540/1-86/003. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1984b. Health Effects Assessment for Methylene Chloride. ECAO-CIN-HO28. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1984c. Health Effects Assessment for Ethylbenzene. ECAO-CIN-HOO8. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1984d. Health Effects Assessment for Tetrachloroethylene. ECAO-CIN-H009. U.S. Environmental Protection Agency. Environmental Criteria and Assessmsent Office. Cincinnati, Ohio.

EPA. 1984e. Health Effects Assessment for Toluene. ECAO-CIN-HO33. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1984f. Health Effects Assessment for Xylene. ECAO-CIN-HOO6. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

EPA. 1985a. Addendum to the Health Assessment Document for dichloromethane. EPA/600/8-82/004FF. U.S. Environmental Protection Agency. Office of Health and Environmental Assessment, Washington D.C.

EPA. 1985b. Health Assessment Document for Tetrachloroethylene (Perchloroethylene). EPA/600/8-82/005F. U.S. Environmental Protection Agency. Office of Health and Environmental Assessment, Washington D.C.

EPA. 1986a. Superfund Public Health Evaluation Manual. EPA/540/1-86/060 U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington D.C.

EPA. 1986b. Draft Addendum to the Health Assessment Document for tetrachloroethylene. EPA 600/8-82/005 FA U.S. Environmental Protection Agency. Office of Health and Environmental Assessment, Washington D.C.

EPA. 1987. Draft Addendum to the Health Assessment Document for Dichloromethane. EPA 600/8-87/029A U.S. Environmental Protection Agency, Office of Health and Environmental Assessment. Washington D.C.

Faustov, A.S. 1958. Toxicity of aromatic hydrocarbons I. Comparative toxicity of some aromatic hydrocarbons. II. Some problems of the toxic hygiene properties of aromatic hydrocarbons. Tr. Voronezh. Med. Inst. 35:247-255; 257-262.

Faustov, A.S. 1960. Change of relative toxicity in a homologous series of benzene derivatives related to the means of entrance into the organism. Tr. Voronezh. Med. Inst. 73(4):41-46.

Federal Register. 1980. Water Quality Criteria Documents; Availability U.S. Environmental Protection Agency. FR 45 (231):79318-79356.

Federal Register. 1986a. Guidelines for Exposure Assessment. U.S. Environmental Protection Agency. FR. 51(185):34042-34054.

Federal Register. 1986b. Guidelines for the Health Assessment of Suspect Development Toxicants. U.S. Environmental Protection Agency. FR. 51(185): 34028-34040.

Federal Register. 1986c. Guidelines for Mutagenicity Risk Assessment U.S. Environmental Protection Agency. FR. 51(185):34006-34012.

Federal Register. 1986d. Guidelines for Carcinogen Risk Assessment. U.S. Environmental Protection Agency. FR. 51(185):33992-34003.

Federal Register. 1986e. Guidelines for the Health Risk Assessment of Chemical Mixtures. U.S. Environmental Protection Agency. FR. 51(185): 34014-340225.

Hake, C.L. and R.D. Stewart. 1977. Human exposure to tetrachloroethylene, In: Some Halogenated Hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. WHO, IARC, Lyon, France. Vol. 20, p.491-514.

Hardin, B.D., G.P. Bond, M.R. Sikov, F.D. Andrew, R.P. Beliles and R.W. Niemeier. 1981. Testing of selected workplace chemicals for teratogenic potential. Scand. J. Work Environ. Health. F (Suppl.4): 66-75.

Harris, B. 1983. Ethylbenzene. Reportable quantity RQ) ranking based on chronic toxicity. Prepared by Syracuse Research Corporation under Contract 68-03-3112 for the ECAO, Environmental Protection Agency. Cincinnati, Ohio.

HLA. 1987a. Subsurface Investigation Proposed Housing Areas 1 and 2 Ex-Hunters Point Naval Shipyard. Prepared by Harding Lawson Associates. Novato, California. October 30, 1987.

HLA. 1987b. Scoping Document Remedial Investigations/ Feasibility Studies. Naval Station Treasure Island Hunters Point Annex. Harding Lawson Associates. Novato, California. November 13, 1987.

Hudak, A. and G. Ungvary. 1978. Embryotoxic effects of benzene and its methyl derivatives: Toluene, xylene. toxicology. 11:55-63.

Kabata-Pendias. A., and A. Pendias. 1984. Trace Elements in Soil and Plants. CRC Press. Boca Raton, Florida.

Lehmann, K.B. and L. Schmidt-Kehl. 1936. The thirteen most important chlorinataed aliphatic hydrocarbons from the standpoint of industrial hygiene. Arch. Hyg. 116:131-268.

Levaggi, D.A., J.S. Sandberg, M. Feldstein and S. Twiss. 1976. Total anthropogenic suspended particulate as derived from chemical analysis of chloride and silicate on high-volumn samples. APCA Journal 26:554-558.

NAS. 1978. Nonflorinated halomethanes in the environment. National Academy of Sciences. Washington, D.C.

NOAA. 1982. Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-80, California. National Oceanic and Atmospheric Administration.

NIOSH. 1984. NIOSH Manual of Analytical Methods, Third Edition. Volume 1. United States Department of Health and Human Services. Public Health Services. Centers for Disease Control. National Institute for Occupational Safety and Health. Division of Physical Sciences and Engineering. Cincinnati, Ohio.

Nomiyama, K. and H. Nomiyama, 1974. Respiratory retention, uptake, and excretion of organic solvents in man. Benzene, toluene, n-hexane, trichloroethylene, acetone, ethyl acetate, and ethyl alchol. Int. Arch. Arbeitsmed. 32(1-2):75-83.

NRC. 1983. Risk Assessment in the Federal Government: Managing the Process. Committee on the Institutional Means for Assessment of Risks to Public Health. Commission on Life Sciences. National Research Council. Academic Press. Washington D.C.

Riihimaki, V., P. Pfaffli, K. Savolainen and K. Perari. 1979. Kinetics of M-xylene in man: General features of absorption, distribution, biotransformation, and excretion in repetitive inhalation exposure. Scand. J. Work Environ. Health.

Rowe, V.K., D.D. McCollister, H.C. Spencer, E.M. Adams and D.D. Irish. 1952. Vapor toxicity of tetrachloroethylene for laboratory animals and human subjects. Arch. Ind. Hyg. Occup. Med. 5:566-579.

Savolainen, K., D. Pfaffli, M. Helojoki and M. Tengen. 1979. Neurochemical and behavioral effects of long-term intermittent inhalation of xylene vapor and simultaneous ethanol intake. Acta. Pharmacol. Toxicol. 44(3):200-207.

Schlocker, J. 1974. Geology of the San Francisco North Quadrangle, California. Geological Survey Professional Paper 782. United States Government Printing Office. Washington D.C.

Schwetz, B.A., B.K.J. Leong and P.J. Gehring. 1974. Embryo- and fetotoxicity of inhaled carbon tetrachloride, 1,1-dichloroethane and methylethyl-ketone in rats. Toxicol. Appl. Pharmacol. 28(3): 452-464.

Schwetz, B.A., B.K. Leong and P.J. Gehring. 1975. The effect of maternally inhaled trichloroethylene, perchloroethylene, methyl chloroform, and methylene chloride on embryonal and fetal development in mice and rats. Toxicol. Appl. Pharmacol. 32:84-96.

Shigeta, S., H. Aikawa and T. Misawa. 1982. Effects of maternal exposure of toluene during pregnancy on mouse embryos and fetuses. Tokai. J. Exp. Clin. Med. F(2):265-270.

Smyth, H.F., C.P. Carpenter, C.S. Weil, V.C. Pozzani and J.A. Striegel. 1962. Range finding toxicity data. List VI. Am. Ind. Hyg. Assoc. J. 23:95.

Stewart, R.D. 1969. Acute tetrachloroethylene intoxication. J. Am. Med. Assoc. 208(8): 1490-1492.

Stewart, R.D., E.D. Baretta, H.C. Dodd and T.R. Torkelson. 1970. Experimental human exposure to tetrachloroethylene. Arch. Environ. Health. 20:224-229.

Suhr, E. 1975. Comparative Investigation of the State of Health of Gravure Printers Exposed to Toluene. Gesellschaft zur Forderung des Tiefdrucks E.V., Weisbaden, Federal Republic of Germany, 92p.

Takeuchi, Y., Y. Ono, N. Hisanage, et al. 1983. An experimental study of the combined effects of n-hexane and methylethylketone. Br. J. Ind. Med. 40(2): 199-203.

Tatrai, E., K. Rodics and G. Ungvary. 1980. Embryotoxic effects of simultaneously applied exposure of benzene and toluene. Folia Morphologica 28(3):286-289.

Tatrai, E., G. Ungvary, I.R. Cseh, et al., 1981. The effect of long-term inhalation of o-xylene on the liver. Ind. Environ. Xenobiotics, Proc. Int. Conf. p. 293-300.

Towill, L.E., C.R. Shriner, J.S. Drury, A.S. Hammons and J.W. Holleman. 1978. Review of the Environmental Health Effects of Pollutants: III Chromium. EPA-60011-78-023. U.S. Environmental Protection Agency. Office of Research and Development, Cincinnati, Ohio.

Ungvary, G., S. Manyai, E. Tatrai, et al. 1980. Effect of toluene inhalation on the liver of rats--Dependence on sex, dose, and exposure time. J. Hyg. Epidemiol. Microbiol. Immunol. 24:242-252.

von Oettingen, W.R. 1964. The Halogenated Hydrocarbons of Industrial and Toxicological Importance. Elsevier Press, Amsterdam. p.271-283.

WESTEC. 1984. Initial Assessment Study, Hunters Point Naval Shipyard (Disestablished). WESTEC Services Inc. October, 1984.

Wilson, R.H. 1943. Toluene poisoning. J. Amer. Med. Assoc. 12:1106.

Wolf, M.A., V.K. Rowe, D.D. McCollister, R.L. Hollingsworth and F. Oyen. 1956. Toxicological studies of certain alkylated benzenes and benzene. Arch. Ind. Health. 14F:387.

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DRAFT RISK ASSESSMENT PROPOSED HOUSING AREAS 1 AND 2

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